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Botany

Claude Bailey, Jr., Chair

FLORISTIC STUDIES IN THE BIG SANDY UNIT OF THE TENNESSEE NATIONAL WILDLIFE REFUGE, BENTON AND HENRY COUNTIES, TENNESSEE. **Edward W. Chester**, *Austin Peay State University, Clarksville, Tennessee*. The Tennessee National Wildlife Refuge was established in 1945 and includes 51,400 acres, mostly associated with the impounded Tennessee River (Kentucky Lake). The Refuge is comprised of three discontinuous units: Busseltown (Decatur County), Duck River (Humphreys), and the northernmost unit, Big Sandy, that includes about 21,400 acres in parts of Benton and Henry counties. The Big Sandy Unit is topographically diverse with habitat types ranging from upland forests, deep water rivers and embayments, shallow embayments with emergent vegetation, swamps, marshes, moist-soil management areas, dewatered flats, and agricultural and successional fields, among others. Floristic studies, including 45 trips during the growing seasons of 1989–2011, documented a flora of 612 taxa. Poaceae (80) and Asteraceae (76) are the largest families, *Carex* (17) the largest genus, and *Quercus* (12) the largest woody genus. Tennessee-listed taxa include one special concern (*Schoenoplectus fluviatilis*, river bulrush) and two threatened species (*Stylisma humistrata*, Southern Dawn-Flower, and *Heteranthera limosa*, Blue Mud Plantain).

BIOTIC AND ABIOTIC FACTORS INFLUENCING THE QUALITY OF CUMBERLAND SEEPAGE FORESTS AND THE IMPLICATIONS FOR THE SURVIVAL OF *PLATANThERA INTEGRILABIA*. **Todd Crabtree**, *Tennessee Natural Heritage Program, Nashville, Tennessee*. The Cumberland Seepage Forest is an ecological system that includes a rare to uncommon association designated as the *Acer rubrum* var. *trilobum*—*Nyssa sylvatica*/*Osmunda cinnamomea*—*Chasmanthium laxum*—*Carex intumescens*/*Sphagnum lescurii* forest. This association is globally rare to uncommon and contains the globally rare orchid, *Platanthera integrilabia*. Several factors influence the quality of this rare habitat. Geology, soils, topography, precipitation, non-native species, anthropogen-

ic disturbance, and other factors have negative or positive effects on the quality of the system. The complex interaction of all factors may lead to any quality of habitat from poor to good for *Platanthera integrilabia* within the Cumberland Seepage Forest.

FOSSIL FRUITS OF ICACINACEAE FROM THE EOCENE OF TENNESSEE AND MISSISSIPPI: A BIOGEOGRAPHIC LINK WITH MODERN SOUTHEAST ASIA. **Gregory W. Stull, B. Roger Moore, and Steven R. Manchester**, *Florida Museum of Natural History, Gainesville, Florida*. We report on three recently described taxa of the pantropical family Icacinaceae from the Eocene Claiborne Group of Tennessee and Mississippi, the first recognition of this family from the Mississippi Embayment of southeastern North America. *Natsiatum wilcoxiana* and *Phytocrenedensi punctata* from Tennessee represent extant genera presently confined to Southeast Asia and Malaysia. *Croomiocarpon mississippiensis* from Mississippi is considered an extinct genus with affinities to the tribe Iodeae. These fossil fruits increase the generic diversity of Icacinaceae's paleontological record and improve our understanding of the phylogeographic distribution of the family.

VASCULAR PLANTS OF FIVE MOUNTAIN FENS IN NORTHEASTERN TENNESSEE. **Christy T. Carter and Mark G. McIntosh**, *Tennessee Technological University, Cookeville, Tennessee*. Southern Appalachian fens are unique habitats that possess characteristics of both bogs and fens. Although such wetlands display some of the highest diversity values in the Southern Appalachian region and provide habitat for many rare plant species, they are frequently under-surveyed. The flora of five montane fens was surveyed in and around Shady Valley, Tennessee, in Johnson and Carter counties. The resulting checklist contains 98 species representing 69 genera and 32 families, including eight species of ferns and 90 species of flowering plants. Four species are non-native. Two taxa represent new listings for Carter County and 17 taxa represent new listings for Johnson County. Eleven species are currently listed as endangered, threatened, or of special concern in the State of Tennessee. [See the full article starting on p. 28 of this issue.]

* Student Presenter.

WATCH YOUR ASH: EMERGING INVASIVE FOREST PESTS IN TENNESSEE AND IMPLICATIONS FOR FIREWOOD UTILIZATION. **David A. Lincicome**, *Tennessee State Parks, Nashville, Tennessee*. Emerald ash borer (EAB) (*Agrilus planipennis*) and thousand cankers disease (TCD) (*Geosmythi amor-bida*) were first detected in Tennessee during July 2010. EAB attacks ash species (*Fraxinus* spp.) and is a federally quarantined pest. The TCD fungus attacks black walnut (*Juglans nigra*) and butternut (*J. cinerea*), and is a state quarantined pest. The quarantines aim to slow the spread of these pests, and maintain marketability of forest products and ecological health of forests. The distribution along commerce routes suggests that humans may play a role in the movement of these pests. Raw wood products should not be moved outside quarantined counties. One vector is the movement of infested firewood. To help prevent the spread of these pests, a campaign has been initiated to educate the public about the dangers of bringing firewood into campgrounds. The public is being advised to buy local firewood and not to move firewood greater than 50 miles.

PRELIMINARY RESULTS OF THE VASCULAR FLORA AND BROAD SCALE HABITAT TYPING OF THE CHEATHAM WILDLIFE MANAGEMENT AREA, CHEATHAM COUNTY, TENNESSEE. **Clea F. Klagstad* and Dwayne Estes**, *Austin Peay State University, Clarksville, Tennessee*. The Cheatham Wildlife Management Area (CWMA), comprising 8,422 ha in Cheatham County, Tennessee, is owned and managed by the Tennessee Wildlife Resources Agency (TWRA). It is located in the lower, central part of the county, approximately 64 km west of Nashville, Tennessee. Situated in two physiographic provinces—the Western Highland Rim and a small portion of the Outer Central Basin—the Cumberland River borders the CWMA to the north and the Harpeth River to the west. A total of 27 trips to the refuge yielded an inventory of 400 species thus far. Each species received a broad habitat description from the communities encountered, both natural and anthropogenic, for the purpose of land management. Fifty-two species (17%) of the flora are introduced. Four species were documented as having a state or federal listing: *Helianthus eggertii*, *Hydrastis canadensis*, *Juglans cinerea*, and *Panax quinquefolius*.

INVESTIGATING *CLEMATIS* L. SUBGENUS *VIORNA* A. GRAY: A CLOSER LOOK AT THE EASTERN NORTH AMERICAN VIRGIN'S BOWERS. **Kevin J. Minchew* and Joey Shaw**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. *Clematis* is a genus in the family *Ranunculaceae* that includes nearly 300 species worldwide. About 30 species occur in North America. The taxonomic history of the genus is fraught with inconsistency and confusion, particularly in the North American species, often referred to as the "Viorna group." Largely due to its enormous morphological diversity, this group has undergone inconsistent revision since it was first recognized. Several taxonomic treatments have given some insight into the relationships within *Clematis*, but no treatment has given

any insight into relationships within "Viorna." Few molecular data have been used to investigate relationships within *Clematis*, and virtually none regarding the North American species. The nrDNA gene region ITS was used to test the monophyly of "Viorna," and our preliminary data suggest that it is monophyletic. We are currently working to add another nuclear gene region to illuminate species relationships within "Viorna," which contains many rare Appalachian species.

THE VASCULAR FLORA OF THE OCOEE RIVER GORGE, POLK COUNTY, TENNESSEE. **S. Hart*, D. Estes, E. Blyveis*, and J. Shaw**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee (SH, EB, and JS), and Austin Peay State University, Clarksville, Tennessee (DE)*. The Ocoee River Gorge (ORG) is located in the southern portion of the Cherokee National Forest in Polk County, Tennessee. This area represents the ecotone between the Blue Ridge Mountains and the Ridge and Valley Province. The purpose of this study was to document the flora of the ORG with a focus on documenting rare plant populations. During the 2010 and 2011 growing seasons, 83 collecting trips were made to the ORG, and approximately 1000 specimens were collected. Fifteen endangered, threatened, or special concern species were documented. Six of these species are endangered (*Agalinis plukenetii*, *Coreopsis delphinifolia*, *Lysimachia fraseri*, *Pityopsis ruthii*, *Sedum nevii*, and *Trillium rugelii*), five threatened (*Chrysogonum virginianum*, *Diervilla rivularis*, *Lobelia amoena*, *Thermopsis fraxinifolia* and *Trichomanes petersii*), and four of special concern (*Acer leucoderme*, *Galium uniflorum*, *Panax quinquefolius*, and *Symplocos tinctoria*). Three introduced species—*Lathyrus sylvestris*, *Parthenocissus tricuspidata*, and *Scandixpecten-veneris*—are new to Tennessee.

IMPACTS OF LARGE ANIMAL HERBIVORY ON *SCUTELLARIA MONTANA* IN THE TENNESSEE ARMY NATIONAL GUARD VOLUNTEER TRAINING SITE, CATOOSA COUNTY, GEORGIA. **Andrea R. Benson*, Joey Shaw, and Jennifer Boyd**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. *Scutellaria montana* Chapm. (large-flowered skullcap) is a federally listed herbaceous perennial with a population in the Tennessee Army National Guard Volunteer Training Site (VTS), Catoosa County, Georgia. To examine impacts of deer and feral hog herbivory on *S. montana* within the VTS, we implemented an experiment consisting of small and large animal exclosures, large animal only exclosures, and non-exclosures controls. Preliminary results from summer 2011 indicate that stem height and number of leaves per plant decreased across all treatments. Compared with individuals protected from both small and large herbivores, mean stem height decreased ~5% more with protection from large herbivores only and 13% more for non-exclosures individuals. Results suggest that large herbivores are grazing *S. montana* individuals, but that smaller animals are equally contributing to *S. montana* herbivory at the VTS.

MAPPING THE VEGETATIONAL ECOLOGICAL SYSTEMS AND ASSOCIATIONS OF THE OCOEE RIVER GORGE, POLK COUNTY, TENNESSEE. **Joey Shaw, Sunny Hart, Emily Blyveis, and Dwayne Estes**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee (SH, EB, and JS)*, and *Austin Peay State University, Clarksville, Tennessee (DE)*. The Ocoee River Gorge (ORG) lies entirely within the Cherokee National Forest and is bisected by U.S. Hwy 64—a major east–west corridor through the southern Appalachian Mountains. During fall of 2009, rockslides blocked U.S. 64, and it remained closed until April, 2010. The Appalachian Region Commission estimated that \$197 million in costs were imposed on the region. New road construction was proposed to bypass this rockslide-prone area. Our research is focused on mapping the ecological formations through proposed alternate alignments around the ORG. We collected vegetational data from >120 sites and used these data in conjunction with SEGAP and USGS orthoimagery to build a geographic information system of the ecological systems within the proposed alignments. Five natural forest and woodland communities were mapped along with one savanna and shrub steppe community (possibly new to science), one herbaceous wetland, and two mixed upland wetlands. Two disturbed communities were documented.

THE VASCULAR FLORA AND PHYTOGEOGRAPHICAL ANALYSIS OF THE TENNESSEE RIVER GORGE, HAMILTON AND MARION COUNTIES, TENNESSEE. **Emily R. Blyveis* and Joey Shaw**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. An inventory of the vascular flora of the Tennessee River Gorge (TRG) was conducted between April 2009 and July 2011. The 4,970 ha (12,281 acres) study area is located on the Cumberland Plateau physiographic province in Hamilton and Marion counties, Tennessee. Six hundred ninety-two taxa were identified, representing 392 genera from 123 families. Ten rare species were reported, including *Castanea dentata*, *Cotinus obovatus*, *Lonicera dioica*, *Panax quinquefolius*, *Scutellaria montana*, *Viola tripartita* var. *tripartita*, *Hydrastis canadensis*, *Onosmodium bejariense* var. *hispidissimum*, *Phemeranthus mengesii*, and *Polymnia johnbeckii*. Ninety-two introduced taxa were identified, including *Lonicera japonica*, *Paulownia tomentosa*, and *Pueraria montana*. A phytogeographical analysis was conducted for the TRG and twelve other Cumberland Plateau floras. The TRG flora has affinities to Eastern North America. However, 9.5% had southern distributions, and 3.3% had northern distributions. The central and southern Cumberland Plateau in Tennessee maintains a southern floristic element.

A NEW SPECIES OF *PENSTEMON* (PLANTAGINACEAE) FROM TENNESSEE AND ALABAMA. **Dwayne Estes**, *Austin Peay State University, Clarksville, Tennessee*. *Penstemon* is a large genus of 270+ species endemic to North America. Twenty species are native to the eastern U.S. During spring 2011, an undescribed species of *Penstemon* was

discovered during studies of herbarium specimens and field work in the southern Cumberland Plateau of Alabama and Tennessee. This new species is presumably related to *Penstemon smallii* of the Appalachians and *P. tenuis* of the southern Mississippi River Valley. Like these species, the new species shares closely eglandular-puberulent stems, ovate-lanceolate, subcordate, conspicuously serrated leaves, and corolla throats that are strongly 2-ridged within. The new species is distinguished from both *P. smallii* and *P. tenuis* by its combination of small, pale lavender to whitish corollas, preference for rocky, limestone-derived soils on mountain slopes, and unique geographic distribution. It is currently known from the western escarpment of the Cumberland Plateau in Jackson, Madison, Marshall, and Morgan counties, Alabama, and Franklin County, Tennessee.

THE STATUS OF *RUDBECKIA FULGIDA* VAR. *UMBROSA* (ASTERACEAE) IN TENNESSEE. **Dwayne Estes and Julian Campbell**, *Austin Peay State University, Clarksville, Tennessee (DE)*, and *Lexington, Kentucky*. The *Rudbeckia fulgida* complex has been considered a taxonomically confused group. Two varieties of *R. fulgida* are currently recognized for Tennessee: var. *fulgida* and var. *umbrosa*. Fieldwork, herbarium study, and observations of living plants in common garden settings during the past few years has led to the realization that there are two entities masquerading as var. *umbrosa* in Tennessee. Typical var. *umbrosa* is non-clonal and is restricted to east Tennessee where it occurs in mesic (not wet) forests in the Cumberland Plateau, northern Ridge and Valley, and Blue Ridge. Populations in the Highland Rim and southern Ridge and Valley are very different in their clonal habit, larger heads with more numerous, showier rays, and preference for growing in calcareous seeps and wet prairies. Comparison of seep populations with type specimens indicates that these populations should be referred to *Rudbeckia fulgida* var. *palustris* instead of var. *umbrosa*.

USING LEAF-LEVEL GAS-EXCHANGE CHARACTERISTICS TO INVESTIGATE THE SHADE TOLERANCE OF *CASTANEA DENTATA*, *C. MOLLISSIMA*, AND THEIR HYBRIDS. **Jennifer Boyd, Adam Lyon, and J. Hill Craddock**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. American chestnut restoration efforts include the production of hybrid chestnuts that retain the morphology of American chestnut (*Castanea dentata*) with the blight resistance of Chinese chestnut (*C. mollissima*). However, the short stature and sunny habitats associated with Chinese chestnut suggest it may tolerate shade less well than American chestnut, which could impact hybrid success in forests. We investigated shade tolerance of these chestnut types as determined by leaf-level photosynthetic light responses. Contrary to our predictions, Chinese chestnut exhibited greater photosynthetic rates than American and hybrid chestnuts at relatively low light levels, but was photo-inhibited at higher light levels, suggesting it is comparatively shade tolerant. In

contrast, both American and hybrid chestnuts responded positively to increased light availability, exhibiting greater photosynthetic rates than Chinese chestnut at relatively high light levels. These findings suggest that American and hybrid chestnuts should respond similarly to shaded and open sites (i.e., gaps) in forest systems.

HUMAN IMPACT ON BEAVER FORAGING IN AN URBAN FOREST.

Samuel R King*, **James Helton***, and **Robert E. Loeb**, *Lipscomb University, Nashville, Tennessee (SRK, JH)*, and *Pennsylvania State University—Dubois, Dubois, Pennsylvania (REL)*. The American beaver (*Castor canadensis*) is a welcome addition to Radnor Lake State Natural Area in Nashville, Tennessee. The beavers have been steadily working to convert the streams that feed into Radnor Lake, into marshy bottomlands. The beavers have two large lodges and have constructed an extensive network of canals and check dams. The beavers also have been foraging around the entire circumference of the lake on almost every species of tree, regardless of size. However, the foraging was found to stop at a roadway and dramatically decreased beyond the trails that surround the lake. This brings to light the principle that artificial barriers acts as a boundary for the beavers' foraging. This example of the relationship between human impact and forests will be presented to demonstrate the extent to which human interaction interferes with beaver foraging at Radnor Lake.

CALLUS PRODUCTION FROM LEAF TISSUES OF AFRICAN MAHOGANY (*Khaya senegalensis*). **Danielle Blackstone***, **David Koh***, **Jordann Staples***, and **Mark Bolyard**, *Union University, Jackson, Tennessee*. African mahogany (*Khaya senegalensis*) is native to central Africa and is a potential source of revenue for developing nations in that area, particularly for the new nation of South Sudan. However, this tree is slow growing, seed germination rates are low, and seeds themselves have economic value. The objective of this project is to regenerate African mahogany from leaf tissue as part of an overall strategy of sustainable forestry practice. Leaves have been surface sterilized and treated with a wide range of combinations of growth regulators (BA, Thidiazuron, NAA, IBA, 2,4-D) on several different media (MS, Chu N6, WPM, DKW). To date, a number of treatments have generated sizeable callus cultures, but organogenesis has yet to be observed. While MS was determined to be the optimal media, we plan to test additional cytokinins, including Zeatin, Kinetin, 2iP, CPPU, and PBU, to induce shoot formation.

EFFECTS OF ALLELOPATHIC INTRASPECIFIC COMPETITION ON GROWTH OF PRIVET, *LIGUSTRUM SINENSE*. **Kelly Casarez*** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Allelopathy is an adaptation plants use to chemically compete with other plants and can occur both interspecifically and intraspecifically. Interspecific allelopathy has been shown in the invasive exotic *Ligustrum*

sinense, Chinese privet, but less is known about intraspecific allelopathy occurring in *L. sinense* invaded areas. To test this, 72 *L. sinense* seedlings were transplanted from a recently disturbed area of Shelby Bottoms Park in Nashville, Tennessee, to peat pots in the lab. Leaves from larger, established *L. sinense* plants were also removed and pulverized to make five different concentrations of solution to water the seedlings: 1%, 2%, 3%, 4% and 5% privet. Deionized water was used as a control. Change in height of the seedlings was measured and used to determine if the presence of intraspecific allelopathy can be detected by differences in growth of the seedlings. This study will provide more information about intraspecific competition in *L. sinense*.

Cell and Molecular Biology

Greg Johansen, Chair

SMALL LAMININ PEPTIDES MADE BY SUCCESSIVE DIGESTIONS WITH MATRIX METALLOPROTEINASE-2 AND PROSTATE-SPECIFIC MEMBRANE ANTIGEN ACTIVATE ANGIOGENESIS *IN VIVO*. **Ben Hannah***, **David Bourgeois**, and **Beth Conway**, *Lipscomb University, Nashville, Tennessee*. Angiogenesis has become an important area of cancer-related research in recent years. In particular, prostate-specific membrane antigen (PSMA) has been shown to be implicated in activating angiogenesis. We have shown that small laminin peptides created by successive digestion of human laminin with matrix metalloproteinase-2 (MMP-2) and PSMA activate angiogenesis *in vivo*. We implanted Matrigel plugs containing these peptides into C57BL/6 mice; then we superficially and histologically examined the plugs upon resection after 7 days. Blood vessel formation was quantified by manual counting after H&E staining and by using Drabkin's assay, normalized to total protein levels. Using both methods, blood vessel density was shown to be higher in the plugs containing the small laminin peptides progressively digested by MMP-2 and PSMA than in controls. Overall, this shows that PSMA participates in extracellular matrix degradation and angiogenesis-inducing peptide formation, along with MMP-2, further elucidating one mechanism of angiogenesis in a physiologically relevant context.

THERAPEUTIC INTRAOCULAR ERYTHROPOIETIN GENE THERAPY IN A MOUSE MODEL OF RETINAL DEGENERATION. **Robert S. Parker, II***, **Cody Richardson***, **Rachel Haag***, **Siddharth N. Desai***, **Jessica Hines-Beard**, and **Tonia S. Rex**, *Christian Brothers University, Memphis, Tennessee, and University of Tennessee Health Science Center, Memphis, Tennessee*. A promising neuroprotective agent for the treatment of retinal degenerations is erythropoietin (EPO); however, the intraocular therapeutic dose range is unknown. A retinal degeneration model, the *retinal degeneration slow* mouse, and an inducible promoter system

packaged into a gene therapy vector were used to determine the therapeutic dose. Postnatal day (PD5) mice were injected subretinally with the viral vector. Expression of EPO was induced by treatment with doxycycline. Treatment with varying doses of doxycycline lasted from PD22-PD60. The eyes were collected and analyzed using ELISA or H&E staining of histological sections. Treatment with 0.5 mg/mL doxycycline was not protective and correlated with 25 mU/mL EPO. Treatment with 5 mg/mL doxycycline was protective and correlated with 36.5 mU/mL EPO. Continuous production of at least 36.5 mU/mL EPO in the eye is neuroprotective.

THE EFFECTS OF METHYL MERCURY ON OLIG2 AND NKX2.2A EXPRESSING CELLS DURING ZEBRAFISH DEVELOPMENT OF THE CENTRAL NERVOUS SYSTEM. **Melissa Guest*, Marina Zaky*, and Karen Meisch**, *Austin Peay State University, Clarksville, Tennessee*. Methyl mercury is an environmental organometal neurotoxicant that affects the central nervous system of vertebrates. Few studies observe how methyl mercury affects the development of neuronal cells in embryos. Transcription factors in the CNS are expressed to control differentiation of neuronal glial cells; therefore, analyzing the expression of these transcription factors will prove helpful in understanding the origins of the morphological defects. Because their genomes are 80% similar to humans, comparative data can be gathered. Zebra fish can be transgenic, which allows for the tracking of cells expressing specific transcription factors and their migration. We will be using a confocal microscope to track the migration of cells expressing certain genes and their proliferation through the central nervous system. The differences between the exposed groups and the unexposed groups will be tracked and compared to each other to determine methyl mercury effects on the nervous system of the embryos.

DOES OREGANO HAVE A SYNERGISTIC EFFECT WITH TETRACYCLINE IN THE TREATMENT OF *SALMONELLA TYPHIMURIUM*-INFECTED *DANIO RERIO*? **Ashley Newsome*, Lori L. McGrew, Jennifer T. Thomas, and Rachel Riggsby**, *Belmont University, Nashville, Tennessee*. *Salmonella typhimurium* is a common food-borne pathogen that infects millions of people each year. Like many bacteria, *Salmonella* strains are gaining increasing resistance to traditional antibiotics as more medications are prescribed, creating a need for new antimicrobial agent development. Several studies have shown that oregano has bactericidal effects against *Salmonella* in disk diffusion assays, as well as in treated produce and other food products. Little research has been done to determine whether these antimicrobial effects persist within a *Salmonella*-infected organism, however. *Danio rerio*, or zebrafish, is a vertebrate that possesses both an innate and adaptive immune system similar to that of humans and other higher organisms. Its small size and ease of care make zebrafish a model organism for the current study. We hypothesize that

oregano will display a synergistic effect when combined with the traditional antibiotic, tetracycline, to treat zebrafish infected with *Salmonella typhimurium*.

SPECTROPHOTOMETRIC DETERMINATION OF RESPIRATION RATES IN *C. ELEGANS*. **Monique Parrish* and Robert Grammer**, *Belmont University, Nashville, Tennessee*. As part of an ongoing program of research on the response of *C. elegans* to fluctuations of variables, such as chemoef-factors, pathogens, and food sources in the environment, we are developing a technique for measuring respiration in *C. elegans* with spectrophotometry. In these assays we will observe the effect of mitochondrial inhibitors and mutants, mutants of *C. elegans* in mobility, chemoattractants of *C. elegans*, and various bacterial prey and pathogens. To date we have shown changes in absorbance of pH indicators that are dependent on time, and that rate is dependent on glucose. Studies are continuing to increase the reproducibility and throughput of the assay.

EXON EXPRESSION OF BRAIN-DERIVED NEUROTROPHIC FACTOR IN CANCER CELL LINES, HB-8501 AND PC-3. **Ann Hanna* and Jon H. Lowrance**, *Lipscomb University, Nashville, Tennessee*. Brain-derived neurotrophic factor is a member of the neurotrophin growth factor family necessary for survival, growth, and differentiation of neurons. The BDNF gene is encoded on chromosome 11 in humans and contains 9 different exons. The exon expression of the BDNF gene varies between cell types. This research examined the exon expression in two different human cancer cell lines, PC-3 and HB-8501. PC-3, a prostate adenocarcinoma cell line, showed the expression of exons II, III, and IX, while HB-8501, a line of human B-lymphocyte hybridoma, expressed exons I, II, III, V, VI, and IX. The data indicate that these cancer cell lines use similar exon expression that may play a part in their abnormal state. These results suggest further investigation into the level of expression and the function of BDNF in these cancer cell lines.

Chemistry

Daniel J. Swartling, Chair

FUNCTIONAL STUDIES OF HUMAN DNA POLYMERASE ETA. **Xiaohua Jiang*, Robert Eoff, and Martin Egli**, *Tennessee Tech University, Cookeville, Tennessee (XJ), University of Arkansas for Medical Sciences (RE), and Vanderbilt University, Nashville, Tennessee (ME)*. Human DNA polymerase eta is a tumor suppressor for skin cancer. It bypasses the UV modified DNA which blocks replicative DNA polymerases during DNA replication. The structure of human DNA polymerase eta (1-432aa) has just been solved, but the function of this catalytic core has not yet been examined. We constructed an *E. coli* codon optimized construct of human DNA polymerase eta (1-432aa) and successfully purified the protein from *E. coli*. Our

preliminary data suggest that human DNA polymerase ϵ (1–432aa) has comparable polymerase activities with full-length DNA polymerase ϵ .

SYNTHESIS OF CYCLOPROPYL PEPTIDOMIMETICS AS POTENTIAL BACE AND HCV NS3-4A PROTEASE INHIBITORS. **Norma K. Dunlap, Daniel H. Gouger*, Jessica A. Taylor*, and Jacob H. Basha***, Middle Tennessee State University, Murfreesboro, Tennessee. The utility of peptidomimetics as enzyme inhibitors is well documented in pharmaceuticals. An efficient synthesis of a cyclopropylpeptidomimetic core was developed, allowing access to a number of potential novel medicinal agents. Compounds were synthesized from commercial protected amino acids to afford potential enzyme inhibitors with variations at the P1 site based on the amino acid side chain. In the past ten years, many BACE inhibitors have progressed to clinical development and show potential as novel Alzheimer's drugs. Most of these inhibitors are peptidomimetics with either an isobutyl or benzyl group in the P1 site. Another target is Hepatitis C Virus (HCV), the primary cause of hepatitis infection. A target is the serine protease located at the N-terminal of NS3 protein, which is significant in proteolytic cleavage of nonstructural proteins. Presented here are potential cyclopropylpeptidomimetic inhibitors of both BACE, prepared from CBz-leucine, and HCV NS3-4a protease, prepared from CBz-proline.

SYNTHESIS AND APPLICATION OF BORON-CONTAINING PYRROLE SPECIES. **Rachael S. Hall* and Scott T. Handy**, Middle Tennessee State University, Murfreesboro, Tennessee. The goal of the project is to synthesize pentabromopseudilin, a marine natural product which has shown potential as a lipoxygenase inhibitor. The family of enzymes inhibited by it are responsible for inflammatory response in the body and have also been implicated in a number of human diseases like cancer and asthma. Therefore, pentabromopseudilin could serve as a potential therapy for some of those diseases. Suzuki cross-coupling is very useful for functionalizing heteroaromatic rings and is also therefore of interest for natural-product synthesis. Three different organoboron compounds, boronic acid, boronate, and trifluoroborate, containing pyrrole were synthesized and then used in cross-coupling reactions with iodoanisole, bromoanisole, iodobenzene, and bromobenzene to assess the reactivity of the organoboron compounds and their potential as reagents in the synthesis of pentabromopseudilin.

CONVERSION OF LIGNOCELLULOSIC MATERIAL TO GLUCOSE FOR THE PRODUCTION OF BIOETHANOL. **Miguel A. Hurtado* and Beng G. Ooi**, Middle Tennessee State University, Murfreesboro, Tennessee. This study evaluates the possibility of converting sugar precursors derived from cellulase digestion of kenaf pulp to bioethanol. In order to convert the crystalline cellulosic form to the amorphous form amenable to the enzymatic hydrolysis of the

glycosidic bond, kenaf pulp samples were subjected to different base pre-treatment processes. The pulp samples subjected to microwave-assisted pre-treatments with 2% and 5% sodium hydroxide at 50°C produced a higher glucose yield, when digested with cellulase from *Trichoderma reesei*, than those pre-treated using conventional heating methods. Raman microscopy was used to study the structural changes in the kenaf fibers after the pre-treatment process, as well as after the cellulose digestion. Yeast strains K1-V1116 YEBRL4 and K1-V1116 MGET2 were used to ferment the sugar obtained from kenaf. Formation of ethanol was indicative that these strains were not inhibited by the presence of residual phenolic byproducts from the lignocellulosic digestion of kenaf pulp.

SYNTHESIS OF LABELED MEVALONOLACTONE. **Norma K. Dunlap and David G. Antonelli***, Middle Tennessee State University, Murfreesboro, Tennessee. Dinoflagellates produce an array of steroid biomarkers, and their identification is useful in characterizing these organisms. Although some steroids can be identified by GC-MS techniques, the use of isotope-labeled analogs can be used to help identify biosynthetic pathways active in the organisms. Access to mevalonolactone (an early intermediate in steroid biosynthesis) labeled on the methyl group would aid in the identification of steroid biomarkers in dinoflagellates; however, the only reported synthesis lacks reproducibility. Although there are a number of synthetic approaches to mevalonolactone reported in the literature, very few are amenable to the synthesis of a methyl-labeled analog. A new approach to labeled mevalonolactone is reported here. Initial synthesis has been tested on the non-labeled material, and synthesis of the labeled analog is in progress.

COMPARISON OF TAGGED PROTEIN-ANTIBODY BINDING IN MESOPOROUS AND POROUS SILICA VIA FLOURESCENCE MICROSCOPY. **Samuel T. Mitchell*, Adrienne C. Friedli, and Stephen M. Wright**, Middle Tennessee State University, Murfreesboro, Tennessee. Biosensors can detect natural and man-made biological threats in applications such as food safety, water quality, and medical diagnostics. In a new optical biosensor, a multilayered photonic band gap material (PBG) detects a shift in surface waves as the amount of analyte at the surface changes. The work aims to test the effect of exchanging the final layer of the PBGM for a porous silica layer. Synthesized using a F-127 template within a thin film, the porous layer formed organized pores under controlled drying. The films were treated with 3-aminopropyl triethoxysilane (APTES) to afford biomolecular functionality. Fluorescently labeled bovine serum albumin (BSA-Cy5) was bound to the surfaces with the non-bound regions blocked. The concentration of protein solution was varied to determine detection limits. The samples were exposed to FITC-labeled anti-BSA solutions of varying concentration. The detection limit of anti-BSA was compared for both porous and nonporous, amine-coated surfaces.

Engineering and Engineering Technology

Ismail Fidan, Chair

THE DEVELOPMENT OF A 3-D PRINTING KNOWLEDGE BASE. **Ismail Fidan**, *Tennessee Technological University, Cookeville, Tennessee*. 3-D printing is a form of additive manufacturing technology where a three-dimensional object is created by laying down successive layers of material. 3-D printers are generally faster, more affordable, and easier to use than other additive manufacturing technologies. 3-D printers offer product developers the ability to print parts and assemblies made of several materials with different mechanical and physical properties in a single build process. Advanced 3-D printing technologies yield models that can serve as product prototypes. In summer 2010, a Research Experiences for Teachers (RET) site research was performed to establish a knowledge base among the 3-D printing process variables. Processing time, location, orientation, layer thickness, and cost factors of simple and complex geometries have been benchmarked with ZPrint Software estimated values and real experimental case studies. The findings of the summer research were also beta-tested in senior level manufacturing courses.

AN EXPERIMENTAL REAL-TIME PLATFORM FOR SMART GRID INFORMATION AND COMMUNICATION NETWORKS. **Rami Amiri*** and **Omar Elkeelany**, *Tennessee Technological University, Cookeville, Tennessee*. Embedded system cores for communications networks are becoming quite important recently due to the demands placed by Smart Grid, sensor mobile networks, etc. In this research, we are aiming to achieve a secure and high performance network communication platform based on various implementations of the TCP/IP protocol stack. NicheStack TCP/IP is a light weight library written in C. First we deployed NicheStack TCP/IP for an embedded Web server application. Then we integrated the ECC (Elliptic Curve Cryptography) C code within the web server source code to achieve a secure communication. Consequently, we showed that the integrated system, the web server, and the ECC program hides information if the secret is not provided. Secondly, we are in a stage to design a complete open TCP/IP hard core on an FPGA. Preliminary simulation result via ModelSim confirms proper operation of decode instruction module at the hardware level.

ASSESSING SOFTWARE AND PROTOCOL VULNERABILITIES IN ROUTERS FOR SECURE CLOUD COMPUTING. **Nicholas Luna***, **Hellen Maziku***, **Sachin Shetty**, and **S. Keith Hargrove**, *Tennessee State University, Nashville, Tennessee*. With the rapid increase of interest in cloud technologies, there exists an ever growing need to examine the network security aspects of the cloud. The purpose of this study was to assess the security levels of the routers associated with cloud servers. While the servers of the cloud may be secure, there is a strong likelihood that the routers are not and can provide a viable point of entry for a potential attacker. The vulnerability levels of the routers were assessed by the use of Network Mapper (nmap). The

nmap software was used to determine the status of common networking protocol ports. Routers were clustered into three groups based on the status of their ports: secure, somewhat secure, and insecure. These clusters will help determine secure routes through the cloud, offer a choice of hosting services for cloud servers, and provide valuable insight into a largely unexplored aspect of cloud security.

ROBOTIC SEARCH AND RESCUE IS A CAPSTONE PROJECT EXPERIENCE FOR ELECTRICAL ENGINEERING TECHNOLOGY. **Adel Salama***, **Carl Eisemann**, **Corey Griffin**, **James Hendrick**, and **Chad Schroeder**, *Austin Peay State University, Clarksville, Tennessee*. The concept of the Robotic Search and Rescue (SR²) came about as a result of brainstorming technologies considered worthwhile and beneficial. The details surrounding the sizing and functionality in terms of the sub-systems to be incorporated into the main system were carefully considered to facilitate effective sensing and communication devices capable of bringing potential victims in contact with rescuers remotely. A sturdy but proven platform—the Dagu Wild Thumper 4WD All Terrain Chassis—was chosen for its rugged design and compactness. The compactness would ensure entry into tight spaces en route to targeted areas. The sub-system includes temperature sensor for capturing the thermal stays for both indoor and outdoor. There is also video technology that is capable of wireless transmission. A simplistic, two-way walkie-talkie-based voice communication system is also included on the list of features for the SR², providing vocal interaction between rescuers and personnel that may be isolated or trapped.

THE EFFECT OF ADVANCED APPLICATION TECHNOLOGY ON CONSTRUCTION PROJECT MANAGEMENT. **Ihab S. Habib and Abu Sarwar**, *Austin Peay State University, Clarksville, Tennessee*. The development of new applications for cell phones, such as I phone 4 and Androids, has made a direct effect on construction project management. The instant access between field construction engineers, architects, subcontractors, and their suppliers has made coordination and decision making instantaneous. Field inspection and report documents are shared with office engineers who can update and make necessary design changes. Fast response to outstanding issues, emergencies, or accidents has become instantaneous through the use of instant videos or photos from hand-held phone cameras. GPS and video conferencing maintain hourly worker monitoring on remote job sites. With the application of new technologies, construction project management has become easier, faster, and more reliable. Money can be saved on projects by using the new, advanced, readily available technology.

Geology and Geography

Robert Mark Simpson, Chair

THE NEW NORMAL: AN ASSESSMENT OF THE NEW CLIMATE NORMALS FOR TENNESSEE, 1981–2010. **Robert Mark Simpson**,

University of Tennessee at Martin, Martin, Tennessee. This past July, the National Climate Data Center released the new statistical normals for temperature and precipitation for the United States calculated from data taken from January 1981 to December 2010. Every ten years, these new normals are calculated from daily and hourly reports from cooperative observers, forecast offices, and other federally sanctioned weather stations. It is not appropriate to draw any conclusions as to how the new normals compare with the old ones, because the methodology for arriving at the normals for 1981–2010 is different from the methodology for the previous thirty years (1971–2000). However, this study maps and analyzes these new normals for Tennessee as a first step to understanding patterns of climate and climate change within the state.

THE BEN E. CLEMENT MINERAL MUSEUM'S FOSSIL AND GEOLOGIC CURIOSITIES COLLECTION. **Michael A. Gibson, Elaina Gibson*, Walter Markin, Mary Stinson*, Laura N. F. Tucker*, and Lawanda Virgous***, *University of Tennessee at Martin, Martin, Tennessee.* The Ben E. Clement Mineral Museum (Marion, Kentucky) houses a high-quality mineral collection, especially noted for fluor spar minerals, mining artifacts, maps, and records from the Western Kentucky Fluorspar District. Less well-known are undocumented fossils, sedimentary structures, and "curiosities." As a service learning project, the 2011 UTM Paleobotany class conducted a "forensic reconstruction" of the collection yielding 218 specimens (172 fossil plants [168 Carboniferous; 4 Paleogene-Neogene], 29 invertebrates and ichnofossils, and 17 sedimentary-diagenetic features [ferricrete, leisegang, septarian nodules]). The Carboniferous plant collection most likely was local Western Kentucky coalfield sourced. Clement seemed to prefer collecting tree trunk and woody material of *Lepidodendron*, *Sigillaria*, *Stigmaria*, and *Calamites*, over leafy material as only three specimens of leaves (*Pecopteris* and *Neuropteris*) occur in the collection. UTM prepared a summary report of the collection and designed educational displays for museum visitors that include taxonomy, functional morphology, and paleoecology using the Clement Museum Fossils.

Health and Medical Sciences

Nick Ragsdale, Chair

CLINICAL AND MOLECULAR CHARACTERIZATION OF CFTR MUTANTS $\Delta F508$ AND R347P. **Joseph W. Fong*, Sunitha Yarlagadda, Dennis C. Stokes, and Anjaparavanda P. Naren**, *Christian Brothers University, Memphis, Tennessee (JWF), The University of Tennessee Health Science Center, Memphis, Tennessee (SY, APN), and Le Bonheur Children's Hospital, Memphis, Tennessee (DCS).* Cystic fibrosis (CF), caused by mutation of cystic fibrosis transmembrane conductance regulator (CFTR), is a lethal autosomal recessive disease characterized by progressive lung disease and resulting bacterial respiratory infection,

pancreatic insufficiency, and high sweat chloride levels. Two female siblings, patients of the University of Tennessee Cystic Fibrosis Care and Research Center at Le Bonheur Children's Hospital (UTCFCRC-LBCH), have paired CF mutations $\Delta F508/R347P$, determined by genotyping. The objective of the study is to investigate CFTR intracellular trafficking and molecular characterization of $\Delta F508$ and R347P to better understand associated CF-phenotype. Iodide efflux assay and Western blotting were used to evaluate CFTR function and expression. Cultured at 28°C opposed to 37°C, $\Delta F508$ and R347P exhibited rescued CFTR function and increased expression. CF corrector C3 increases max iodide efflux of uncorrected R347P-CFTR from ≈ 0 pmol/min to ≈ 3 pmol/min. R347P-CFTR exhibits practically no iodide efflux function and patients with $\Delta F508/R347P$ exhibit typical CF symptoms.

ENDOTHELIN CONVERTING ENZYME-1 EXPRESSION IS UP-REGULATED IN INVASIVE HUMAN BREAST CANCER. **Reem Sidani*, Marina Salama*, and Beth Conway**, *Lipscomb University, Nashville, Tennessee.* The Endothelin-1 Pathway has been implicated in the invasiveness of cancer cells. Endothelin Converting Enzyme-1 (ECE-1) cleaves Big Endothelin-1 into Endothelin-1, binding to receptors. These receptors activated signaling pathways leading to various functions including, in some cell types, invasion. ECE-1 has been found to be a link in the invasiveness of certain cancer cells, such as prostate, ovarian carcinoma, and neuroblastoma cells. Four ECE-1 isoforms have been identified, with certain isoforms up-regulated in certain cancer cells mentioned. The contribution of these individual isoforms to invasion has not been studied in breast cancer cells. We tested these isoforms in the invasive MB-MDA-231 cell line and the less invasive MCF-7 cell line to determine isoform expression patterns. We hypothesized that ECE-1 would be up-regulated in highly invasive breast cancer cells. We found that the MB-MDA-231 cell line had increased levels of ECE-1B and ECE-1D compared to the MCF-7 cells.

NEPRILYSIN NEGATIVELY REGULATES HUMAN BREAST CANCER CELL INVASION. **Marina Salama*, Reem Sidani, and Beth Conway**, *Lipscomb University, Nashville, Tennessee.* Neprilysin/CD-10 is a membrane-bound protein that catalyzes the cleavage of active endothelin (ET-1) to inactive protein fragments, thus inhibiting the ET-1 signaling pathways that lead to cell proliferation, motility, and invasion. We hypothesized that neprilysin will negatively regulate breast cancer cell invasion and will therefore be upregulated in low invasive breast cancer cells. Using invasion assays, we treated low invading MCF-7 cells with Thiorphan, a neprilysin inhibitor, and we observed an increase in cell invasion. Similarly, neprilysin mRNA was consistently detected in low invading, but not highly invasive, breast cancer cells. These results suggest that neprilysin down-regulation may be an important step in breast cancer cells becoming highly invasive; therefore, neprilysin may be an effective target for breast cancer therapy.

STUDY OF THE ROLE OF PMK-1 AND PCD PATHWAYS IN *C. ELEGANS* INFECTED WITH *E. FAECIUM*. **Azad Karim*** and **Nick Ragsdale**, Belmont University, Nashville, Tennessee. *Enterococcus faecium* is an opportunistic human pathogen that is one of the most common organisms recovered from nosocomial infections. *E. faecium* is beginning acquire antibiotic resistance; therefore, scientists are looking to find its mode of infection. *Caenorhabditis elegans* is used as the model organism to determine if PCD is a successful defense mechanism against *E. faecium* infections. In order to answer this question, three different worms, N₂, nsy-1, and sek-1, were tested against *E. faecium* for an 8-h period. N₂ worms are used as control, while the nsy-1 and sek-1 worms have elevated and inhibited levels of PCD, respectively. The mortality rate of each type of worm exposed to the bacteria is recorded and analyzed. Because PCD is a normal defense mechanism used against many bacterial infections, I predict the nsy-1 worms with elevated levels of PCD will survive *E. faecium* infection better than the N₂ and sek-1 worms.

METABOLIC CHANGES IN *CAENORHABDITIS ELEGANS* INFECTED WITH *PSEUDOMONAS AERUGINOSA* OR *STAPHYLOCOCCUS AUREUS*. **Laura Muck*** and **Nick Ragsdale**, Belmont University, Nashville, Tennessee. The purpose of this experiment was to investigate the occurrence of metabolic changes during a *P. aeruginosa* or *S. aureus* infection within a *Caenorhabditis elegans* host. Metabolism was measured using a dissolved oxygen sensor probe after growing *C. elegans* on lawns of either *S. aureus* or *P. aeruginosa* for 48 h. *C. elegans* grown on NGM plates for 48 h served as the control. Dissolved oxygen data were collected for 180 sec, after which the slope of the graph was obtained. It was hypothesized that *C. elegans* infected with *P. aeruginosa* or *S. aureus* would exhibit reduced metabolism and thus produce less of a slope than the control. The results indicate that there is not a significant difference between the control and treated groups ($P > 0.05$), suggesting that exposure to *S. aureus* or *P. aeruginosa* does not affect the metabolism of *C. elegans*.

ROLE OF DAF-2 INSULIN/IGF-I LIKE AND P38 MAP KINASE PATHWAYS IN *CAENORHABDITIS ELEGANS* INFECTED WITH *SALMONELLA TYPHIMURIUM*. **Roxy Musharrafia*** and **Nick Ragsdale**, Belmont University, Nashville, Tennessee. *Salmonella typhimurium* are gram negative bacteria pathogenic to a wide range of host organisms and a serious source of illness to humans throughout the world. It has been shown that various immunologic pathways play significant roles in fighting off infection with *S. typhimurium* and that the nematode *Caenorhabditis elegans* displays homologues to these pathways. For this reason, along with its vulnerability to *S. typhimurium*, *C. elegans* is a model organism in the study of host-pathogen interactions. In this study, it was questioned whether the IGF-1 pathway plays a role in eliciting an immune response upon pathogenic invasion of *Salmonella typhimurium*. We were curious as to whether this pathway plays more or less of a role than does

the already studied MAP kinase pathway. Results did not demonstrate that the IGF-1/Insulin-like pathway in *C. elegans* shows active immunologic resistance against *S. typhimurium*. However, the IGF-1/Insulin-like pathway elicits less resistance than does the MAP-K homologue.

INVESTIGATION OF SOD OVEREXPRESSION IN 6-HYDROXYDOPAMINE TREATED *CAENORHABDITIS ELEGANS*. **Samera Berhane*** and **Nick Ragsdale**, Belmont University, Nashville, Tennessee. Parkinson's disease (PD) is a progressive degenerative neurological disorder characterized by asymmetric onset of resting tremor, rigidity, and bradykinesia in the limbs followed by postural instability. It is identified by the degeneration of dopamine neurons. It is believed dopamine degeneration is in response to neurotoxins triggered in the presynaptic dopamine transporters. The neurotoxin identified as the cause of PD is 6-hydroxydopamine (6-OHDA), which releases free oxygen radicals and inhibition of mitochondrial functions. Dopamine is affected by the neural sensitivity of 6-OHDA, causing mitochondrial dysfunction and neural cell death. Using *Caenorhabditis elegans* helped identify some roles of dopamine and 6-OHDA in neurodegeneration. *C. elegans* is a model organism for experiments on PD. *C. elegans* was treated and evaluated through chemotaxis assay to determine the speed and overall movement between the different mutants. The chemotaxis index indicates there is a difference in speed and movement between the treated and untreated nematodes.

THE EFFECTS OF D₁-LIKE DOPAMINE RECEPTORS ON THE CHEMOTAXIS OF *CAENORHABDITIS ELEGANS*. **Sylvia Chac*** and **Nick Ragsdale**, Belmont University, Nashville, Tennessee. Parkinson's disease (PD), a chronic neurodegenerative disorder caused by the death of dopaminergic neurons, presently has no cure. Individuals affected by PD exhibit the characteristic triad of bradykinesia, tremors, and gait disturbances. The key neurotransmitter, dopamine, plays a major role in the mammalian central nervous system, and there are two known types of dopamine receptors. The D₁-like receptors are excitatory and the D₂-like receptors are inhibitory. In this research, the roundworm, *Caenorhabditis elegans*, is utilized as a model organism for its remarkably similar nervous system to summarize the findings of the effect of the D₁-like antagonist on D₁-like receptors and, thus, the effect on chemotaxis. The D₁-like antagonist did not significantly change the rate of chemotaxis.

History of Science

Brother Kevin Ryan, Chair

AN ACCOUNT OF THE GEOCENTRIC ASTRONOMY CONFERENCE HELD IN 2010. **Brother Kevin Ryan, FSC**, Christian Brothers University, Memphis, Tennessee. Galileo was wrong; the church was right; the Sun goes around the Earth; the Earth does not spin. What? One would think that this was decided about 400 years ago; some people think otherwise. An account of this conference will be given.

HISTORICAL TIMELINE FOR THE DEPARTMENT OF CHEMISTRY AND MIDDLE TENNESSEE STATE UNIVERSITY. **Martin V. Stewart and Terrence A. Lee**, *Middle Tennessee State University, Murfreesboro, Tennessee*. As one would expect, the development of the Chemistry Department at Middle Tennessee State University went through various stages from 1909 to the present: Normal school, State Teachers College, University...more students, faculty, degrees, buildings and many other things will be explained.

Mathematics and Computer Science

Ben Ntatin, Chair

COMPUTATIONAL ANALYSIS OF THE BUGEY NEUTRINO OSCILLATION EXPERIMENT. **Mason T. Yost***, *Austin Peay State University, Clarksville, Tennessee*. The Bugey 3-Detector neutrino experiment attempted to place a limit on $\Delta_{1,2}^2$ and $\sin^2(2\theta_{1,2})$ by calculating neutrino fluxes from a nuclear reactor. This experiment was unusual because it utilized data taken from three different distances from the neutrino source. The experiment concluded that neutrinos did not oscillate between flavors. However, this conclusion was later contradicted and overruled by data from more accurate neutrino oscillation experiments, and recent discoveries suggest that a fourth neutrino may exist. To help determine the plausibility of a four-neutrino model, we are reexamining data from the Bugey experiment. Although our attempts to recreate the original experimenter's results have yielded some success, we have not yet been able to fully recreate the original experimenter's results.

MAXIMUM CAPACITY OF BEADS IN A GIVEN JAR. **Megan N. Alvarez***, **Cortney L. Bramlett***, and **Hyejeong Song***, *Austin Peay State University, Clarksville, Tennessee*. Given a random jar, the objective was to determine the maximum number of beads that could occupy that given jar. Overall, the method for solving this problem remained the same: divide the volume of the jar by the volume of the bead. Doing so would yield the number of beads that could occupy that given volume. However, the methods used to determine the volume of the bead varied in effectiveness. The final and most effective method required a double integral to determine the volume of the removed cap of the bead. Doubling that value and subtracting it from the total volume of the sphere yielded a final volume of the bead equal to 304.415 mm^3 . Using the Fundamental *Theorem Governing the Random Packing of Particles*, it was determined that the volume that was actually able to be occupied equaled 327.760 mm^3 . Dividing those two numbers yielded a result that was off from the physical validation by ten beads.

SOME GENERALIZATIONS OF SCHLICHT FUNCTIONS DEFINED USING THE SALAGEAN OPERATOR. **James York-Winegar***, *Austin Peay State University, Clarksville, Tennessee*. We

generalize subclasses of univalent functions defined using the Salagean differential operator. These functions are analytic, and as such have a Taylor series expansion about every point in the unit disk of the form $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$, normalized such that $f(0) = 0$ and $f'(0) = 1$. Our results will generalize known results for several subclasses of univalent functions that are normalized in the unit disk.

CREATING THE IDEAL MATHEMATICS EDIFICE. **Kelsey Phillips**, **Liliana Alvarez**, **Jonathan Clinard**, and **Anne French**, *Austin Peay State University, Clarksville, Tennessee*. This report reviews the ideal mathematics building on the Austin Peay State University campus. Ideas addressed include point of view, size, square footage, design of each floor, aspects of each floor, and estimated materials and cost of building. This design was constructed through students' point of view with keeping staff needs a top priority. The main topics discussed are the design and aspects of each floor due to limitations of contracting and architecture.

MATHEMATICAL MODEL OF A PROSTHETIC HAND FROM THE MANUFACTURING POINT OF VIEW. **Lisa Elliott***, **Tia Guarino***, **Stephanie Jessie***, and **James Winegar***, *Austin Peay State University, Clarksville, Tennessee*. We will model sales of prosthetic hands with emphasis on weight, durability, and aesthetics. We will explore our client base and examine customization through predesigned templates to minimize cost and improve profit. We will use stochastic processes and reward renewal analysis to determine the percentage of markup to achieve profit adequate for business growth. The model will analyze stop time and the ability to level load production lines to approximate required product markup.

ANALYZING MATHEMATICAL BELIEFS USING GEOMETRIC PICTURES. **Stephanie J. Jessie***, *Austin Peay State University, Clarksville, Tennessee*. We study beliefs and attitudes of some middle Tennessee students towards mathematics learning using mathematical pictures drawn by the students themselves. An analysis of these pictures for encoded mathematical beliefs showed in general, that we could divide the belief structure and attitudes of students into categories that were consistent with established categories. However, there emerged a new category that showed a belief system inconsistent with known categories.

KNOTS AND CHIRALITY. **Ramanjit K. Sahi**, *Austin Peay State University, Clarksville, Tennessee*. Knotted molecules play an important role in synthetic chemistry especially from the viewpoint of chirality. A chiral molecule is a molecule that cannot be superimposed on its mirror image. Knot theory has many techniques of proving whether two knots are distinct or not. HOMFLY polynomial is a knot invariant that distinguishes one knot not only from others but also from its mirror image. This latter distinction is essential in determining whether a knot is chiral or not. Using knot theory methods to study chiral knots can be

time and cost effective for synthetic chemist in the study of the properties of chemical compounds.

HOW TO WIN AT BATTLESHIP. **Stephen J. Robinson**, Belmont University, Nashville, Tennessee. At first glance, the popular board game of Battleship does not lend itself to strategy until at least the first successful hit is made. Even then, it is difficult to determine the best grid point to guess at next. However, simulations of possible ship configurations on various board sizes and with different spacings reveal clear patterns of high and low probability ship placement (assuming a random distribution). These patterns can then be used, depending on whether the preceding shot was a hit or miss, to discern the best possible shot paths to take; this ultimately leads to a clear and quantitative advantage over random guessing.

APPLICATION OF OPTIMAL CONTROL TO THE EPIDEMIOLOGY OF MALARIA DISEASE. **K. Okosun, F. Agosto, and Nizar Marcus**, Austin Peay State University, Clarksville, Tennessee (FA), and University of the Western Cape, South Africa (KO, NM). Malaria is a deadly disease transmitted to humans through the bite of an infected female mosquito. In this paper, a deterministic model is presented and studied for the transmission of malaria. Optimal control theory is applied to investigate optimal strategies for controlling the spread of malaria disease using treatment, insecticide treated bed nets, and spray of mosquito insecticide as the system control variables. The possible impact of using combinations of the three controls either one at a time or two at a time on the spread of the disease is also examined.

THE CANTOR SET—A PATHOLOGICAL SUBSET OF THE REALS. **Ben Ntatin**, Austin Peay State University, Clarksville, Tennessee. Georg Ferdinand Ludwig Philipp Cantor (March 3, 1845—January 6, 1918) was a German mathematician who is best known as the creator of modern set theory. Cantor recognized that infinite sets can have different sizes, distinguished between countable and uncountable sets and proved that the set of all rational numbers “Q” is countable while the set of all real numbers “R” is uncountable and, hence, strictly bigger. In this paper we introduce the Cantor set, discuss in detail its geometric construction, provide an arithmetic characterization for it, and discuss some of the properties that make it not just a pathological subset of the reals, but a great source of counter examples in modern analysis.

Microbiology

John M. Zamora, Chair

CHARACTERIZATION OF A *BORRELIA BURGdorFERI* VIRULENCE DETERMINANT FOR DOGS; A PRIME VACCINE CANDIDATE. **Kathryn White*, Elisa Lund, and Chad Brooks**, Austin Peay State University, Clarksville, Tennessee. *Borrelia burgdorferi* (*Bb*) is well recognized as the causative agent of human Lyme disease, but people often forget about the morbidity and mortality of *Bb* infections in dogs. Like humans

but in dogs, *Bb* must maintain a collection of genetics which afford the bacterium strategies to infect, disseminate, and cause disease sequelae. One such gene, *cspZ* encodes a protein that is recognized to bind to factor H proteins, a component of the innate complement cascade system typically found interrupting the cascade. In this study, deletion of the *cspZ* locus resulted in significant mortality of *Bb* mutants by, in theory, the complement cascade, while *cspZ* rescued-mutants returned survival rates equivalent to wild-type. These data identify a major virulence factor for *Bb* pathogenicity in dogs and a prime vaccine target to potentially protect dogs from *Bb* infections.

EVALUATION OF A MAGNETIC-OLIGO BEAD CAPTURE SYSTEM TO ENHANCE PCR DETECTION OF *BORRELIA BURGdorFERI* DNA. **Krystle Irizarry*, Marina Zaky, Jessica Matheson, and Chad Brooks**, Austin Peay State University, Clarksville, Tennessee. When searching for a minute DNA template among a haystack of exogenous DNA using traditional PCR methods, a problem often encountered is the allosteric inhibition due to exogenous DNAs. This is also a problem for detecting *Borrelia burgdorferi* (*Bb*), the causative agent for human Lyme disease, from tissue biopsies. In this study, magnetic beads coupled with specific *Bb*-oligos were used to pre-hybridize with minute *Bb* DNA templates heavily masked by exogenous DNA then later added directly to traditional PCR reactions for detection. In this particular study, the data indicate the magnetic *Bb*-oligo capture system failed to enhance PCR detection of *Bb* from exogenous DNA.

CHARACTERIZATION OF A NOVEL *CLOSTRIDIUM* SPECIES ISOLATED FROM THE CLOACA OF THE YELLOW-BELLIED SAP-SUCKER. **Tiffany Cathey*, Alexandra Proctor*, Sara Shelton*, H. Dawn Wilkins, and Linda K. Husmann**, The University of Tennessee at Martin, Martin, Tennessee. Yellow-bellied Sapsuckers consume plant tissue rich in cellulose as part of their winter diet. We hypothesize that sapsuckers have symbiotic bacteria in their gut to aid in cellulose digestion. The cloaca of a window-killed sapsucker was cultured to screen for bacteria capable of degrading cellulose. Forty-three isolates exhibiting carboxymethylcellulase activity were obtained representing a minimum of five different species. Sequencing of the 16S rRNA genes from the representative isolates of these species indicates that one is a *Clostridium* species exhibiting $\leq 97\%$ similarity to known organisms in databases. This isolate is an aerotolerant, gram-variable, endospore-forming, alpha-hemolytic rod. Biochemical screening indicates that this isolate represents a novel organism distinct from previously described aerotolerant species of the genus *Clostridium*.

FLOURESCENT AND BIOSENSOR DETECTING OF ANTHRAX-SIMULATING SPORES. **Cari E. Jennings*, Brandon Cathey*, William Robertson, and Stephen M. Wright**, Middle Tennessee State University, Murfreesboro, Tennessee. Anthrax is particularly menacing because of its ability to

quickly spread over long distances causing rapid decline and death. This swiftness necessitates a quick, precise method of detecting anthrax spores. The purpose of these experiments was to compare the capabilities of fluorescent detection with those of a flow cell biosensor, using anthrax-simulating spores. This biosensor utilizes the tracking of electromagnetic waves that travel across the surface of photonic band gap material-covered slides. When antibody binds the target spore, a wave shift occurs, revealing the spore's identity without the use of fluorescent markers. Detection of spores was achieved, both with fluorescent antibodies and the biosensor. The minimum number of spores required for detection is comparable for the two methods. This biosensor could be a viable alternative to older, more time-consuming methods of detection and by virtue of its speed, could give victims of an anthrax attack a better chance of survival.

OIL PRODUCTION FROM CO₂ BY MICROALGAE IN A PHOTOBIO-REACTOR USING LIGHT AS ENERGY SOURCE. **Richard Johansen* and Sergei A. Markov, Austin Peay State University, Clarksville, Tennessee.** The oil production by microalga *Neochloris oleoabundans* was studied in a photobioreactor. The *N. oleoabundans* was grown in a photobioreactor for three weeks. Photobioreactor was supplied with gas mixture (5% CO₂ and air). Continuous light was provided by cool white fluorescent lamps (170–180 $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ on the surface of the culture). Algal biomass was harvested at OD₆₆₅ ~ 0.36 corresponding to a chlorophyll concentration of ~ 1.7 $\mu\text{g}/\text{ml}$, and concentrated by sedimentation with subsequent drying under 70°C. Amount of dry algal biomass from 25 L photobioreactor was 73 g. The separation of oil from dried algal biomass was accomplished with help of methanol and heating with subsequent drying. The amount of oily material was expressed as a percentage of algal dry weight. It was found that *N. oleoabundans* cells contain about 10% oil.

Physics and Astronomy

Eugene de Silva, Chair

AN ANALYSIS OF THE PHYSICS PRINCIPLES BEHIND BREAKING TILES. **Eugenie de Silva* and Eugene de Silva, Harvard University, Cambridge, Massachusetts, and Walters State Community College, Morristown, Tennessee.** This work analyzed the physics theories related to breaking tiles in martial arts. The power-break was evaluated using Newton's three laws. The results were then combined with momentum applications to decide the maximum number of tiles that can be broken with a known fixed mass of tiles and the hand. The results were presented with a common formula for future power-breaking applications.

THE JERK VECTOR IN MOTION OF CHARGED PARTICLE UNDER ELECTRIC AND MAGNETIC FIELDS. **Arjun Tan, Brittany Bazzle*, and Mostafa Dokhanian, Alabama Agricultural**

and Mechanical University, Normal, Alabama. The existence of the jerk vector (or second acceleration) is explored in the motion of a charged particle under the action of electric and magnetic fields. Four examples are considered: (1) Charged particle in a uniform electric field; (2) Charged particle in a uniform magnetic field; (3) Charged particle in uniform electric and magnetic fields parallel with one another; and (4) Charged particle in uniform electric and magnetic fields perpendicular to each other. It is found that: (1) A uniform electric field does not produce jerk on a charged particle; (2) A uniform magnetic field produces jerk vector which executes uniform circular motion; and (3) The superposition of a uniform electric field on a magnetic field alters the dynamical vectors such as velocity and acceleration but not jerk.

CLUSTER ANALYSES OF PLANETS AND SATELLITES. **Arjun Tan, Roderick Gray*, and Mostafa Dokhanian, Alabama Agricultural and Mechanical University, Normal, Alabama.** The method of cluster analysis is introduced and applied to the planets of the solar system and the large satellites of the Jovian planets. The cluster analysis of the planets show that they form two dissimilar groups of Terrestrial and Jovian planets and four sub-groups of (1) Mercury and Mars; (2) Venus and Earth; (3) Neptune and Uranus; and (4) Saturn and Jupiter. The cluster analysis of Galilean satellites indicates that all four satellites were quite similar, but they belonged to two groups: (1) Io and Europa; and (2) Ganymede and Callisto. The cluster analysis of the large satellites of Saturn reveals that they belonged to three groups: (1) Mimas and Enceledus; (2) Tethys, Dione, Iapetus and Rhea; and (3) Titan by itself. Finally, the cluster analysis of the major satellites of Uranus indicates that they consist of a larger group of four and Miranda, with the former comprising two sub-groups of (1) Ariel and Umbriel; and (2) Titania and Oberon.

VALIDATION OF A TWO-DIMENSIONAL TSUNAMI MODEL ON A SPHERICAL SURFACE BY THE 2011 PACIFIC OCEAN TSUNAMI. **Arjun Tan, Sihon Crutcher, and Matthew E. Edwards, Alabama Agricultural and Mechanical University, Normal, Alabama (AT, MEE), and U.S. Army Research, Development and Engineering Command, Redstone Arsenal, Alabama (SC).** The March 2011 Pacific Ocean tsunami produced by the Great Japan Earthquake was one of the greatest in recorded history. We have analyzed this event using a two-dimensional tsunami model on a spherical surface. The general agreement between the observed and predicted wave amplitudes validates the basic principles of the model. The enhancing effect on the wave amplitude due to the curvature of the Earth is clearly demonstrated by the wave amplitudes recorded on the coast of Chile in South America. The recorded times of passage of the tsunami at several locations give fair estimates of the average depths of the Pacific Ocean at these locations.

Science and Math Teaching

Kim C. Sadler, Chair

THINKING INSIDE AND OUTSIDE OF THE BOX: CLUB NEUTRON AFTER SCHOOL SCIENCE CLUB. **Kim C. Sadler, Leigh Gostowski, Linda Gilbert, Emily Newton*, and David Green***, *Middle Tennessee State University, Murfreesboro, Tennessee*. The goal of this project was to enhance student knowledge and engagement in science and mathematics in ways that not only improved attitudes about STEM but also extend to subsequent education. Multiple partners collaborated in providing meaningful after school experiences for middle school students through twice a week Club Neutron attendance and in the summer with a thematic Science and Mathematics Camp. Schools were selected for this project on the basis of free and reduced lunch percentages and low comprehensive assessment scores in science and mathematics. Family Science Nights were held bimonthly on site to engage families with their children in science activities. Analysis of baseline and exit survey data from more than 500 participating students suggests questions relating to general interest in STEM show increases after participation in Club Neutron but pursuit of STEM coursework in high school and state science and mathematics assessment scores are inconclusive.

SEMINAR IN BIOLOGY: AN INTRODUCTION TO THE DEPARTMENT FOR NEW MAJORS. **Jennifer T. Thomas**, *Belmont University, Nashville, Tennessee*. Beginning a new major in college can be an overwhelming experience for students, especially freshmen. The *BIO 1000 Seminar in Biology* course at Belmont University is our attempt to familiarize students with the Biology Department and provide resources to them to facilitate successful completion of their undergraduate degrees in Biology in preparation for graduate studies or the workforce. The course objectives include community building, student development (in the form of time management and study skills), course planning, career planning, and networking. Each of these course objectives will be discussed as well as assessment and reflection on changes made to the course in the past 10 years.

DEVELOPMENT AND FACILITATION OF TWO INQUIRY-BASED ENVIRONMENTAL SCIENCE CASE STUDIES FOR HIGH SCHOOL OUTREACH. **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Using an inquiry-based and case study approach, two lab activities were developed for high school juniors and seniors visiting Belmont University for a day of "lab explorations in Environmental Science." One lab focuses on animal (pillbug) behavior in polluted habitats (acid rain, deforestation, phosphate excess) while the other lab requires that students complete a series of lab activities (blood typing, soil analysis, and hair and parasite identification) to solve a crime scene involving an illegally imported South American monkey. Students gain exposure and practice with hypothesis testing, experimental design, microscopes, pH meters, and other basic lab equipment.

This session will describe the lab activities and how Belmont University students have been involved in the development and facilitation of the labs. Evaluations of the project from both student groups suggest that science learning, confidence with scientific equipment, leadership abilities, and interpersonal communication skills are enhanced.

AN UNDERGRADUATE RESEARCH PROGRAM ON CHEMOTAXIS IN *C. ELEGANS*. **Robert Grammer**, *Belmont University, Nashville, Tennessee*. In developing a continuing undergraduate research program, I have sought to establish a line of work that offers maximum flexibility in student design with minimization of time, equipment, and supply costs. The concept of stimulus-response offers the opportunity to examine either recognition of a signal, integration of signal and initiation of response, or the mechanics of response. For a principally undergraduate institution with a heavy teaching load, I feel it important to establish a framework within which students may exercise some creativity in experimental design. Available equipment, cost of supplies, and space for sample growth and preparation are all limited in our institution. One organism that seems to meet many of these challenges is *C. elegans*, one of the principal model organisms of experimental biology. Its genome sequence, availability of mutants, easy husbandry, quick generation time, and production of offspring make it an excellent choice for our circumstances.

TEACHING SCIENTIFIC RESEARCH THROUGH CEDAR GLADE ECOLOGY IN THE NSF GK-12 PROGRAM. **Alison N. Carey*, Christina Nicholas, Mary B. Farone, Kim C. Sadler, and Anthony L. Farone**, *Middle Tennessee State University, Murfreesboro, Tennessee, and Siegel High School, Murfreesboro, Tennessee*. The cedar glades and barrens of middle Tennessee provide a unique research opportunity for Siegel High School's Honors Ecology class. Characterized by shallow soil and exposed limestone bedrock, this ecosystem can be viewed as a limestone island among forested areas. Students are learning about cedar glade plant endemics and geography as they develop ecological hypotheses that can be tested in this unique local environment. By conducting ecological research projects, students are applying the scientific method in a manner we anticipate to impact scientific comprehension, literacy, and understanding about the nature of science.

Zoology

Vincent A. Cobb, Chair

AN ASSESSMENT OF MITOCHONDRIAL DNA VARIATION IN THE SOUTHERN SHORT-TAILED SHREW (*BLARINA CAROLINENSIS*). **A. Christopher Grow*, Juliann L. Waits, Melvin L. Beck, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee (ACG, MLB, MLK), and Southwest Tennessee Community College, Memphis, Tennessee*

(JLW). *Blarina carolinensis* (southern short-tailed shrew) inhabits many habitats in the southeastern United States. Because morphologically the species shows little variation throughout its distribution and karyotypically displays a wide range of diploid numbers, it makes an interesting model for studying spatial associations among populations. Previous investigations have noted genetic differences between populations of the species on eastern and western sides of the Mississippi River and have suggested the need for additional study in order to better understand genetic variation within the species. We are pursuing this task utilizing molecular procedures and present preliminary results of our findings to date. Additionally, we summarize current knowledge of genetic variation within this species.

AVIAN COMMUNITY RESPONSE TO TIMBER HARVEST ADJACENT TO RIPARIAN ZONES AT CATOOSA WMA. **Christine F. Peterson* and Thomas H. Roberts**, *Tennessee Technological University, Cookeville, Tennessee*. Numerous avian species have declined in past decades due to loss and fragmentation of habitat. This study was designed to determine impacts of adjacent timber harvest on riparian avian communities. An analysis of similarity (ANOSIM) revealed that a difference did exist between the treatment areas and the controls. Avian diversity was higher in the two treatment areas due to an increase in species associated with open habitats including field sparrow (*Spizella pusilla*) and indigo bunting (*Passerina cyanea*). Acadian flycatcher (*Empidonax vireescens*), a Partners in Flight priority species, was less abundant ($P < 0.05$) in areas adjacent to harvest, and three other species—hooded warbler (*Wilsonia citrina*), yellow-throated vireo (*Vireo flavifrons*), and Louisiana waterthrush (*Seiurus motacilla*)—also were far less abundant. This study suggests that in landscapes caution must be used when planning harvest due to potential negative consequences to forest interior species.

AN ASSESSMENT OF BIODIVERSITY MEASUREMENTS OF SMALL MAMMALS IN WESTERN TENNESSEE. **Lauren A. Madeira*, Rackella Johnson, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee*. Biodiversity of small mammals (species richness, species evenness, and species abundance distribution) was determined across fragmented landscapes at four sites in western Tennessee. Using transect sampling procedures, trapping was conducted utilizing Sherman live traps from 2010 to 2011. The Shannon-Weiner index was used to determine measures of biodiversity. Species richness varied from as little as four species to six species. Species evenness was low to moderately even and varied from about 0.39 to about 0.59. Species abundance distribution was found to be the greatest for the white-footed deermouse (*Peromyscus leucopus*). Results are discussed in light of previous investigations conducted in western Tennessee.

IS TRAP PLACEMENT A FACTOR IN CAPTURE OF SMALL MAMMALS? **Madison R. Taylor*, Daniel M. Wolcott, A.**

Christopher Grow, and Michael L. Kennedy, *The University of Memphis, Memphis, Tennessee*. In trapping small mammals, trap placement is an issue, especially in edge habitat. With a goal of capture of the greatest number of individuals, investigators have a choice of placing traps such that openings face in toward one habitat or out toward another habitat. Using Sherman live traps and transect sampling, we placed traps (baited with rolled oats) side by side (facing opposite directions) in edge habitats at multiple sites in western Tennessee. Results revealed no statistical difference ($P \leq 0.05$) in placement.

PREDATION ON VISCERA OF HUNTER-HARVESTED WHITE-TAILED DEER. **Edward O. Zahed*, Steve W. Stephenson, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee (EOZ, MLK), and American Ordnance LLC/Milan Army Ammunition Plant, Milan, Tennessee (SWS)*. Viscera (internal organs) from field-dressed white-tailed deer (*Odocoileus virginianus*) make an interesting food patch for predators during the annual hunting season. However, utilization of the food patch within the biotic community is poorly understood. Therefore, we studied predation on viscera of white-tailed deer in Gibson and Carroll counties, Tennessee, during 2011. Internal organs were collected from field-dressed deer and later placed in selected locations for consumption by predators. Infrared-triggered cameras were placed near samples to record the arrival of predators and the predator assemblage. Vultures (*Cathartes* spp.), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), and Virginia opossums (*Didelphis virginiana*) were among the predators recorded.

BIODIVERSITY OF BATS IN WESTERN TENNESSEE. **Jeremy S. Dennison*, Daniel Stanfield, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee (JSD, MLK), and Tennessee Wildlife Resources Agency, Jackson, Tennessee (DS)*. Biodiversity of bats was surveyed at multiple sites in western Tennessee. Standard mist-netting procedures were utilized, primarily across streams, ponds, and lakes, during the summer season. Upon capture, bats were identified to species, sex and age were determined, and weight and forearm length were recorded. After examination, animals were released at the site of capture. In total, eight species were captured. The eastern red bat (*Lasiurus borealis*), tricolored bat (*Perimyotis subflavus*), and evening bat (*Nyctiseius humeralis*) were taken more frequently than other species. The Seminole bat (*Lasiurus seminolus*) was the species taken in fewest numbers. In general, most sites supported a similar assemblage of species.

EFFECTS OF TEMPERATURE AND PRECIPITATION ON THE ORIENTATION AND SUMMER MOVEMENTS OF TERRAPENE CAROLINA. **Joshua Smith*, James Kerfoot, Jr., and James Huggins**, *Southern Illinois University, Carbondale, Illinois (JS), and Union University, Jackson, Tennessee (JK)*.

JH). A three-month seasonal study examined the Eastern box turtle's (*Terrapene carolina*) orientation and movement capabilities, along with the effect of temperature and precipitation on movement. The research was performed at the University of Tennessee's West Tennessee Research and Education Center (WTREC) in Jackson, Tennessee, throughout summer 2010. Radio telemetry and geographic information systems (GIS) were used to track and record the box turtles' movements twice to three times weekly. Temperature and precipitation data were gathered for each individual tracking event from the WTREC onsite weather station. Results indicated that turtles did not show orientation capabilities or travel toward their original locations. Comparisons of elevation and distance data to precipitation and temperature data showed no significant relationship. This study contrasts other studies indicating that turtles orient towards their original home range and provides a foundation for future studies addressing effective plans for conservation and repatriation of this species.

DETECTION OF CHYTRIDIOMYCOSIS IN PENNSYLVANIA AMPHIBIANS. **Rachel Lewis***, **Kurt Regester**, and **Chad Brooks**, *Austin Peay State University, Clarksville, Tennessee (RL, CB)*, and *Clarion University, Clarion, Pennsylvania (KR)*. *Batrachochytrium dendrobatidis (Bd)* is the known fungal agent responsible for Chytridiomycosis, a fatal disease that affects at least 200 species of amphibians on a global scale. Limited research has been conducted in Pennsylvania to determine the geographical extent and severity of Chytridiomycosis in local amphibian populations. Conventional PCR was used to determine presence or absence of *Bd* from skin swab samples collected from *Cryptobranchus alleganiensis*, the Eastern Hellbender, and *Necturus maculosus*, the Common Mudpuppy, from water ways throughout Pennsylvania. The data indicate that *Bd* was present in several animals found in water ways throughout Pennsylvania.

MATERNAL TRANSFER OF METHYLMERCURY CHLORIDE IN *NERODIA SIPEDON*. **J. Patrick W. Cusaac***, **Raymond C. Wright**, **Cassandra Henry**, and **Frank C. Bailey**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Maternal transfer of contaminants (e.g., mercury) is a phenomenon that has been studied to some degree in most vertebrates, with the exception of squamate reptiles. Such transfer could lead to detrimental effects on offspring without the necessity of direct exposure. The purpose of this study was to determine if methylmercury is maternally transferred placentally in Northern Water Snakes (*Nerodia sipedon*). The objective was to show that methylmercury is transferred from adult females to offspring during late stage gestation. Mean liver and muscle mercury concentrations in adult females significantly differed among the doses (ANOVA, $F_{(2,12)} = 6.49$, $P = 0.012$ and $F_{(2,12)} = 61.191$, $P < 0.001$, respectively). Neonatal livers and tail clips also differed (ANOVA, $F_{(2,7)} = 15.590$, $P = 0.004$ and $F_{(2,7)} = 34.537$, $P < 0.001$, respectively). The results indicate that methylmercury is maternally transferred in *N. sipedon*.

THE EFFECTS OF MATERNALLY TRANSFERRED MeHgCl ON NEONATE PERFORMANCE IN NORTHERN WATER SNAKES, *NERODIA SIPEDON*. **Raymond C. Wright***, **J. Patrick W. Cusaac**, **Cassandra Henry**, and **Frank C. Bailey**, *Middle Tennessee State University, Murfreesboro, Tennessee*. In ecotoxicology, reptiles have historically been underrepresented with most studies focusing on the concentration of a contaminant found in an organism at a site. Fewer studies have been conducted to examine the fate or physiological/biochemical effects of contaminants on these animals. This study was designed to look at the effects of maternally-transferred MeHgCl on locomotor performance in Northern Water Snake (*Nerodia sipedon*) neonates. In the study, adult female *N. sipedon* were randomly assigned to one of three treatments: 0, 10, or 10,000 ug/Kg. Fourteen females gave birth and after a two-week acclimation period the neonates were tested for average and maximum terrestrial locomotor speed in a laboratory race track. Mercury analyses of neonate livers indicated that neonates from the high dose treatment had the highest concentration of Hg. No statistical difference was found in speed of locomotion between treatments (ANOVA, $F_{2,11} = 0.021$, $P = 0.980$).

COMPARING METABOLIC RATES OF FOSSORIAL AND TERRESTRIAL SNAKES. **Jacob Campbell*** and **Vincent A. Cobb**, *Middle Tennessee State University, Murfreesboro, Tennessee*. We used a closed-system respirometry to measure oxygen consumption on two fossorial and two terrestrial snake species under normal and simulated hypoxic/hypercapnic environments at three temperatures (15, 25, and 30°C). Basal metabolic rate (BMR) was calculated by placing individuals in a respirometry chamber and measuring VO_2 every hour for 24 h using normoxic air; hypoxic/hypercapnic simulations were performed by flowing air from pre-filled gas tanks (15% O_2 and 5% CO_2) through the respirometry set-up and measuring VO_2 every hour for 12 h. At normoxic conditions, terrestrial species had higher BMRs than the fossorial species, particularly at the warmer temperature treatments. At hypoxic/hypercapnic conditions, BMRs remained similar to normoxic conditions for fossorial species but a rapid increase in BMR for terrestrial species was associated with the highest temperature treatment. Fossorial snakes may exhibit reduced metabolic rates as well as other mechanisms to handle hypoxic/hypercapnic conditions that more terrestrial species may have lost.

SCALING THE FEEDING MECHANISM OF PIKE KILLIFISH (*BELO-NESOX BELIZANUS*). **James Kerfoot, Jr.**, and **Thomas Duncan***, *Union University, Jackson, Tennessee*. The scaling of the feeding mechanism of pike killifish (*Belonesox belizanus*) was investigated to determine what functional changes occur in the feeding mechanism through ontogeny. It was hypothesized that linear measurements of the jaw would scale isometrically and that estimates of mechanical advantage would have no

relationship as the individual grows. Preserved species from age 0-days post birth (dpb) to 21-dpb were cleared and stained. Jaw lever arms and ratios were measured and regressed against standard length. Results indicated that allometric scaling relationships were observed in the lever arm ratios and body size, rejecting the hypothesis of isometric growth through ontogeny. There was also no significant relationship between mechanical advantage and standard length. This study has shown the feeding mechanism scales allometrically, indicating a potential mechanism that may influence feeding behavior through ontogeny. This provides the foundation for future studies examining the feeding kinematics and behavior of this species.

CRANIAL AND PECTORAL OSTEOLOGY OF THE COMMON CARP, *CYPRINUS CARPIO* LINNAEUS, 1758: A LABORATORY APPROACH. **Michael A. Anderson***, **Eric R. Salmon***, and **George W. Benz**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The vertebrate cranium has been modified numerous times throughout the course of evolution. In addition to its primary function of exogenous feeding and prey capture, the cranium is housing for the nervous, optic, otic, olfactory, and, in fish, respiratory systems. Perhaps more important to biologists, phylogenetic relationships between groups of organisms can be elucidated by evaluating conserved regions of articulation, homologous bones, and the general arrangement of skeletal components. With the intention of introducing young scientists to piscine cranial anatomy, we have created a guide to the cranial and pectoral osteology of the common carp, *Cyprinus carpio*. However, because c. 32,000 species of fish have been described, this manual should be used only in an introductory capacity. Nevertheless, the student who chooses to follow this manual closely and becomes familiar with basic piscine osteology and terminology will be well-suited to begin investigating the primary literature on the subject.

CHANGES IN THE FISH ASSEMBLAGE IN RESPONSE TO RESTORATION OF A CHANNELIZED STREAM IN WEST TENNESSEE. **Tom Blanchard and Brad Ray**, *University of Tennessee at Martin, Martin, Tennessee*. In aquatic systems, the loss of habitat heterogeneity due to channelization is known to affect community structure. As a result, stream restoration has become an important conservation tool. In 2008, the West Tennessee River Basin Authority began the restoration of a portion of Crooked Creek (a tributary of the South Fork Obion River) in Carroll County, Tennessee. Approximately 3000 m of length was added by constructing a new, meandering channel. The newly constructed channel was connected in August of 2010. Our goal was to document the response of the fish assemblage to the restoration. We used back-pack electrofishing surveys to compare the channelized portion to that of the newly constructed reach. Our initial findings indicate that species richness and diversity are substantially lower than those of the channel-

ized reach. We expect that, as physical and biological factors change, more species will colonize this reach.

DIVERSITY AND CONSERVATION STATUS OF THE CRAYFISHES OF THE APPALACHIAN PLATEAU. **John W. Johansen*** and **Hayden T. Mattingly**, *Tennessee Technological University, Cookeville, Tennessee*. Almost 50% of North American crayfish are designated as vulnerable to extinction. Recent studies have highlighted crayfish conservation at a state scale. Few studies have looked at this issue on a physiographic region scale. The purpose of this study was to provide an overview of the diversity patterns and current conservation status of the Appalachian Plateau crayfish fauna and to identify areas where conservation efforts could be focused. Sixty-three species representing four genera are found along the Appalachian Plateau. Fourteen species are considered at risk of extinction. The Cumberland Plateau and Kanawha sections had the greatest species richness and the highest number of at-risk species. Diversity was lower in the northern sections and in the mountain sections on the eastern border of the plateau. Because the main threat was limited geographic range, localized conservation strategies like the Cumberland Habitat Conservation Plan may be the most effective strategy in protecting this fauna.

INFECTION RATES OF *TRYPANOSOMA CRUZI* IN WILDLIFE FROM RURAL AREAS OF MIDDLE TENNESSEE. **Rachel K. Serfass***, **RaeAnne N. Lauffer**, and **C. Steven Murphree**, *Belmont University, Nashville, Tennessee*.

INFECTION RATES OF *TRYPANOSOMA CRUZI* IN WILDLIFE FROM SUBURBAN AREAS OF MIDDLE TENNESSEE. **RaeAnne N. Lauffer***, **Rachel K. Serfass**, and **C. Steven Murphree**, *Belmont University, Nashville, Tennessee*. *Trypanosoma cruzi* is the causative agent of Chagas disease and is enzootic in the Southeastern United States. The numbers of wildlife species infected by this parasite, which is transmitted by conenose bugs (*Triatoma* spp.), may vary depending upon whether they occur in rural or suburban areas. Procedures will involve live-trapping, anesthetizing and taking blood samples from individual opossums (*Didelphis virginiana*) under veterinary supervision. Serum samples obtained through centrifugation will be amplified using PCR then tested for the presence of *T. cruzi* using an immunofluorescent assay. Infection rates of opossums collected in rural/suburban areas will be presented and compared to those reported from opossums collected in suburban/rural areas.

THE INFLUENCE OF TEMPERATURE ON THE FEEDING RATES OF TWO INTRODUCED SPECIES, *ASTRONOTUS OCELLATUS* (OSCAR) AND *ARCHOCENTRUS NIGROFASCIATUS* (ONVICT CICHLID): IMPLICATIONS FOR THEIR SUCCESSFUL ESTABLISHMENT IN FLORIDA. **Chelsea Harden***, **Mollie Carter**, **Jared Littlejohn**, **Dakota Tracy**, **Tara Tucker**, and **James Kerfoot, Jr.**, *Union University, Jackson, Tennessee*. Introduction of a species into a novel environment may

subject them to a suite of new challenges. Introduced *Archocentrus nigrofasciatus* have established in central Florida, whereas introduced *Astronotus ocellatus* have remained in South Florida. The objective of this study was to investigate the influence of temperature on the feeding rates of these two introduced species. The feeding rates of individuals fed at 20, 25, and 30°C were recorded. Results indicated that for each species there was no significant difference in feeding rate across temperatures or between species. However, there was a significant interaction between temperature and species. *Astronotus ocellatus* maintained similar feeding rates with *Archocentrus nigrofasciatus* at 20 and 25°C, but increased their feeding rate significantly at 30°C. This study reveals that differences in the effect of temperature on the feeding rates of these introduced species may be a plausible mechanism limiting their distributions.

REPELLENT PROPERTIES OF STONE MINT, *CUNILA ORIGANOIDES*, AGAINST THE AMERICAN DOG TICK, *DERMACENTOR VARIABILIS*. **Elizabeth R. Thorndike*** and **C. Steven Murphree**, Belmont University, Nashville, Tennessee. Public concern about diseases vectored by ticks has led to the development of novel tick repellents throughout the United States. In recent years, researchers have worked towards developing plant-based repellents that are as effective as their synthetic counterparts. In this study, the repellency of the native herb *Cunila origanoides* against *Dermacentor variabilis* was studied using an *in vitro* assay. The herb was blended into a slurry and distilled using steam distillation. The essential oil was chemically separated and further isolated with a rotary evaporator. The essential oil was tested at three concentrations, 10%, 25%, and 50%, in acetone. Significant repellency was detected at all concentrations. The results of this study suggest that natural plant-based repellents could be produced to effectively guard against tick-borne diseases.

PREFERRED MICROHABITAT CONDITIONS FOR *CENTRUROIDES VITTATUS* IN MIDDLE TENNESSEE. **Ryan P. Baker*** and **C. Steven Murphree**, Belmont University, Nashville, Tennessee. Microhabitat preferences of *Centruroides vittatus*, known only from a single population near Murfreesboro, were studied using a soil temperature probe, an infrared thermometer, and a spring scale. Data were collected from 30 randomly selected rocks believed to have the best chance of harboring *C. vittatus*. The parameters measured for each rock included soil temperature around and beneath, surface temperature, surface temperature beneath, relative humidity around and beneath, greatest length and weight. Only six of the 30 rocks studied were found to harbor *C. vittatus*. A Kruskal-Wallis test was used to make a comparison of the conditions studied as they related to the presence of *C. vittatus*. Only relative humidity beneath rocks and rock size produced statistically significant results using a 90% confidence interval. The data suggest that *C. vittatus* in Middle Tennessee is more likely to be found under larger rocks with lower relative humidity.

TREATING *DANIO RERIO* WITH THE NEUROTOXIN 6-OHDA TO STUDY MOVEMENT DEFICITS. **Tristan Daniel*** and **Lori L. McGrew**, Belmont University, Nashville, Tennessee. Parkinson's Disease (PD) is a neurodegenerative disease that results from a loss of dopamine producing neurons. Dopamine is important for proper motor function, and this loss of dopamine signaling causes the signs of PD. In the U.S. alone PD currently affects one million individuals. Because zebrafish are vertebrates with significant homology to humans, this study was designed to target the dopaminergic neurons of the zebrafish to mimic the signs present in individuals with PD. 6-Hydroxydopamine (6-OHDA) has been shown to kill dopaminergic neurons and mimic Parkinson's disease in other animal models. In this study zebrafish treated with 6-OHDA exhibited motor dysfunction. There was a dramatic decrease in the distance the zebrafish could travel after treatment. Additional fish were treated with the toxin in the presence of a dopamine transporter blocking agent to determine whether 6-OHDA was acting on central dopaminergic neurons or locally at the peripheral motor neurons.

NICHE PARTITIONING OF CENTRARCHID SUNFISH IN A MIDDLE TENNESSEE STREAM. **Phillip Parsley*** and **John Niedzwiecki**, Belmont University, Nashville, Tennessee. The effects of competition and realized niches are important concepts for any ecological community. In this study, three species of Centrarchid sunfishes were observed and studied to further learn more about their respective niche in a portion of the Little Harpeth River in Davidson County, Tennessee. *Lepomis macrochirus*, commonly known as bluegill sunfish, *Lepomis cyanellus*, referred to as green sunfish, and *Lepomis megalotis*, known as longear sunfish, were the species that all occurred in the same stretch of river. Their location within a stream pool was recorded and chi-square contingency tables were calculated. No statistical findings show that they are partitioning habitat within the pool. Further tests are planned to examine diet.

EFFECTS OF RIPARIAN TREE CANOPY ON WATER QUALITY AND THE OCCURRENCE OF WATERPENNIES (BEETLE LARVAE) IN THE LITTLE HARPETH RIVER. **Jordan Murray*** and **Darlene Panvini**, Belmont University, Nashville, Tennessee. Studies on riparian zones and stream systems suggest that physical and chemical factors of streams can be affected by the presence of tree canopy. These abiotic factors can then influence the presence of biota in a stream. Waterpennies (beetle larvae) are common indicator species used to assess the health of streams. As part of a national study examining the influence of riparian tree canopy on stream temperature, the occurrence of waterpennies was determined and correlated with stream temperature, dissolved oxygen, pH, and total dissolved solids. Waterpennies were counted on 45 rocks distributed among riffles in both open canopy and closed canopy reaches once per month for five months (June–October, 2011). Number of waterpennies will be correlated with presence of tree canopy, size of

rock, and abiotic factors to assess the impact that tree canopy has on stream quality.

NEST SITE CHARACTERISTICS OF GREAT BLUE HERONS AND GREAT EGRETS IN THREE ROOKERIES AT REELFOOT LAKE, TENNESSEE. **Taylor Ricks*** and **H. Dawn Wilkins**, *University of Tennessee at Martin, Martin, Tennessee*. Herons and egrets nest in rookeries often located over water to possibly avoid predation. Our goals were to describe the species composition of three rookeries, to determine if nest site partitioning was occurring, and to compare the structure of the three rookeries. For each tree, we recorded the diameter at breast height, the distance from the nearest boundary, and the number of nests. For each nest, we noted the species, nest height, and location within the tree. Large diameter trees tended to support more nests. The number of nests in a specific tree appeared to be related to crown structure. The density of nests was highest in the center of the rookery. Great Blue Heron (*Ardea herodias*) nests were often in central forks. Great Egret (*Ardea alba*) nests were on peripheral branches and appeared less stable. Further observations may determine if these two species interact as they select nesting sites.

POPULATION SURVEY OF THE STREAMSIDE SALAMANDER, *AMBYSTOMA BARBOURI*, IN THE INNER AND OUTER NASHVILLE BASINS OF MIDDLE TENNESSEE. **Michael A. Anderson***, **Joshua R. Campbell**, **Alison N. Carey**, **Derec R. Dodge**, **Ryan A. Johnston**, **Emily R. Mattison**, **Ryan J. Seddon**, **Nathan L. Singer**, and **Brian T. Miller**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The streamside salamander, *Ambystoma barbouri*, inhabits upland deciduous forests associated with ephemeral first- and second-order streams throughout Middle Tennessee. The geographic range of *A. barbouri* extends as far north as Indiana, and isolated Middle Tennessee populations demarcate the southern range of the species. Historically, within the Outer Nashville Basin (ONB) breeding populations have been found in Davidson County, and juveniles have been found in Jackson County. However, the current status of these populations remains unknown, with the former presumed extirpated as a result of urbanization of metropolitan Nashville. We surveyed streams in the northern Inner Nashville Basin (INB) and the western and eastern ONB to find new breeding localities of *A. barbouri* and to connect currently known populations to historic sites. Eggs and larvae were found in a first-order stream in Wilson County. Additionally, eggs were found in a first-order stream in Trousdale County, signifying a new county record for the species.

AN ONGOING SURVEY OF THE HERPETOFAUNA OF TWO NATIONAL WILDLIFE REFUGES WITHIN THE REELFOOT LAKE COMPLEX. **Keith Paluso***, **Steven Pitts**, **James Stewart**, and **Tom Blanchard**, *University of Tennessee at Martin, Martin, Tennessee*. Although the Reelfoot Lake area in northwest Tennessee is known to support a diverse

assemblage of amphibians and reptiles, there have been no regular sampling efforts with the intent of long-term monitoring. We used a combination of techniques to document amphibian and reptile species on the Reelfoot National Wildlife Refuge (RNWR) and Lake Isom National Wildlife Refuge (LINWR). Both refuges include bottomland hardwood forests of similar composition, but the RNWR is much larger and has more undisturbed habitat. The goals of this study, as the first long-term sampling effort of the Reelfoot Lake area, are to describe the herpetofaunal assemblage of the area and to compare species richness and composition between the two wildlife refuges. To date, we have documented over 1000 animals representing 40 species. Both richness and composition at the two sites were similar, but there were some species unique to each refuge.

TERRESTRIAL ANIMAL DIVERSITY IN TWO MIDDLE TENNESSEE FRESHWATER WETLANDS. **Megan DeVries*** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Decisions regarding wetland protection, restoration, and mitigation include analyses of a variety of abiotic and biotic factors, as well as the relationships between these features that comprise a wetland. This project examines how two factors, size and degree of naturalness, affects terrestrial animal diversity by compiling a species list for two middle Tennessee wetlands: a small, mitigated area and a larger, natural area. Species lists are not known for either site. The diversity of terrestrial animals in each wetland was tested over a period of six weeks using four collection methods: pitfall traps, cover boards, sweep nets, and small animal traps. Numerous insects, spiders, and mollusks were collected and identified at both sites. Jacquard's Coefficient of Community Similarity was used to compare diversity in the two wetlands. Upon completion of this study, the relationship between diversity of terrestrial animals, wetland size, and degree of human involvement will be discussed.

USE OF SILENT POINT COUNTS AND AURAL STIMULI TO DETECT BARRED OWLS IN THE AREA SURROUNDING REELFOOT LAKE, TENNESSEE. **Sarah E. Redding*** and **H. Dawn Wilkins**, *University of Tennessee at Martin, Martin, Tennessee*. Barred Owls are important in forested ecosystems as nocturnal predators. Protocols for censusing Barred Owls vary. Our goal was to standardize census methods by comparing silent counts to counts using aural stimuli. Ten points were established and sampled twice a month from February to March. At each point, we conducted 5- and 10-min silent counts followed by playback of Barred Owl calls. We divided the time post-playback into 5-, 10-, 15-, and 20-min intervals. Ten-min silent counts detected more owls than 5-min silent counts. Five-min post-playback counts detected as many owls as 10-, 15-, and 20-min post-playback counts. When comparing silent counts to counts using aural stimuli, 10-min silent counts detected approximately the same number of owls as 5-min post-playback

counts, but the number of calls detected increased significantly post-playback. Aural stimuli may improve detection of owls in areas of low density.

PHYLOGEOGRAPHY OF SHORT TAILED SHREWS (GENUS: *BLARINA*) OF SOUTHEAST TENNESSEE. **Casey Carpenter***, **Timothy Gaudin**, **Joey Shaw**, and **Thomas Wilson**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. Shrews of the genus *Blarina* are among the most common small mammals of the southeastern United States. Two species are found in the area surrounding Chattanooga, Tennessee: *Blarina brevicauda*, the northern short-tailed shrew, and *Blarina carolinensis*, the southern short-tailed shrew. In an effort to clarify geographic ranges of the two species in southeast Tennessee, *Blarina* vouchers were collected and mitochondrial DNA cytochrome *b* genes were isolated and sequenced. These sequences were then compared to GenBank data, and phylogenetic relationships were determined for the vouchers. Results indicate *Blarina brevicauda* is found in areas north and west of the Tennessee River and *Blarina carolinensis* is found in areas south and east of the Tennessee River. Most *B. brevicauda* specimens from the study area were similar to haplotypes classified as either 'Appalachian' or 'East-Central'. *Blarina carolinensis* specimens were monophyletic and more similar to *B. carolinensis* from Arkansas, Illinois, and Louisiana rather than to those from Georgia, Florida, and Virginia.

DISTRIBUTION AND ABUNDANCE OF *OPIOTHRIX SUENSONII* ON SPONGE VS. NON-SPONGE REEF SURFACE AREA AT WHALE SHOALS PATCH REEF IN BELIZE. **Will J. Evans***, *St. Andrews Sewanee School, Sewanee, Tennessee*. The morphological and chemical properties of sponges can offer unique habitat opportunities to brittle stars in coral reef environments.

This study tests for the existence of an association between a brittle star (*Opiothrix suensonii*) and a tube sponge (*Callyspongia vaginalis*) in a Belizean patch reef. Frequencies of *O. suensonii* on paired plots with and without *C. vaginalis* clusters were compared. Brittle star abundance was significantly greater on plots containing *C. vaginalis*; individuals were densely packed within and between the sponge's protective tubes. Few brittle stars could also be found clinging to Porifera with lesser structural protection, suggesting the presence of defensive chemical mechanisms. Known cleaning symbioses between other *Opiothrix* species and Porifera suggest the possibility of a similar mutualism between *O. suensonii* and *C. vaginalis*. The results of this study highlight the importance of species-specific invertebrate symbioses in Belizean patch reefs.

PHYLOGEOGRAPHIC COMPARISON OF *CENTRUROIDES VITTATUS* POPULATIONS IN MIDDLE TENNESSEE AND CENTRAL ARKANSAS. **Thomas A. Homonnay***, **John H. Niedzwicki**, and **C. Steven Murphree**, *Belmont University, Nashville, Tennessee*. In order to test the hypothesis that an isolated middle Tennessee population of the striped scorpion, *Centruroides vittatus*, has long been separated from western populations, specimens were collected and extracted DNA was amplified using PCR using primers specific for the mitochondrial COA gene. After purification techniques were employed, gel electrophoresis produced bands consistent with those reported in previous studies of western populations. Samples will be sequenced and compared to published sequences from those populations. Phylogenetic trees will be constructed using maximum likelihood methods, and resulting trees will be used to evaluate hypotheses regarding the origins of the middle Tennessee population.

Abstracts Presented at the 2010 Annual Meeting of the Tennessee Academy of Science **

EXPRESSION LEVELS OF SELECTIN IN HUMAN PAPILLOMAVIRUS POSITIVE AND NEGATIVE CELL LINES. **Matthew C. Turner*** and **Jennifer T. Thomas**, *Belmont University, Nashville, Tennessee*. (Note: The paper for this abstract was presented at the 2010 Annual Meeting and at the 2011 Collegiate Meeting; the abstract for this paper was printed in *JTAS* 86 (3-4): 109-110.)

ENDOTHELIN CONVERTING ENZYME-1 EXPRESSION LEVELS IN BREAST CANCER CELLS. **Ben Kellum***, **Amanda D. Williams**, and **Beth Conway**, *Lipscomb University, Nashville, Tennessee*. Endothelin Converting Enzyme-1 (ECE-1) converts Big Endothelin to its active form, Endothelin.

While the expression of ECE-1 has been correlated with increased invasion in some types of cancer, it has not been well studied in breast cancer. We hypothesized that ECE-1 is up-regulated in invasive human breast cancer cell lines. Using two different human breast cancer cell lines, the low invading MCF-7 line and the highly invasive MDA-MB-231 line, we examined the levels of 4 ECE-1 isoforms. Because our previous studies using quantitative reverse transcription polymerase chain reaction (RT-PCR) had technical limitations and inconsistencies, we used standard RT-PCR with digital imaging and quantitation. We found that in the highly invasive MDA-MB-231 cells, expression levels for ECE-1B were down-regulated, while ECE-1C was significantly up-regulated compared to MCF-7 levels. ECE-1a and ECE-1d were not consistently detected in either cell line. Further research will be done to study the functional differences in these isoforms to breast cancer progression.

* Student presenter.

** These abstracts were omitted from the *Journal of the Tennessee Academy of Science* 86 (1).

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SMALL EXTRACELLULAR MATRIX PEPTIDES REGULATE ENDOTHELIAL CELL ACTIVATION. **Bobby Rampp***, **Alex Patterson***, **Amanda D. Williams**, and **Beth Conway**, Lipscomb University, Nashville, Tennessee. Angiogenesis is regulated by numerous factors, including the extracellular matrix (ECM) and large ECM fragments. ECM clearance by proteases is one of the initial steps in the formation of new blood vessels. Matrix metalloproteases (MMPs), the major class of proteases implicated in angiogenesis, degrade numerous intact ECM proteins to fragments ranging from 20-50 kDa in size. However, multiple other proteases required for angiogenesis do not efficiently degrade large proteins and prefer small peptide substrates. However, the contribution of small ECM peptides to angiogenesis has not been studied. We hypothesize that these proteases may contribute to angiogenesis by producing small, bioactive peptides from larger degradation fragments from the ECM. Using major components of the ECM such as collagen and laminin, we generated small peptides and tested endothelial cell activation using adhesion assays. Our results show that endothelial cell activation is increased in the presence of small ECM peptides, thus supporting our hypothesis.

BRAIN DERIVED NEUROTROPHIC FACTOR EXPRESSION IN PROSTATE CANCER CELLS DURING STRESS. **Kyle Brawner***, **Amanda D. Williams**, and **Jon Lowrance**, Lipscomb University, Nashville, Tennessee. The neurotrophins are a family of proteins that were first identified as neuronal growth factors, but they are expressed in other cell types as well. Previous studies of the prostate cancer cell line PC-3 have indicated that of all the neurotrophins, NGF is most responsible for *in vitro* invasion, with BDNF not seeming to affect metastasis. Instead of playing a role in invasion, we hypothesized that BDNF has a survival function in PC-3 cells. To test this hypothesis, we starved cells of serum and collected RNA after 3-48 hours of serum deprivation. We then performed reverse transcription polymerase chain reaction and found that BDNF and intracellular sortilin, a protein responsible for neurotrophin transport in other studied cells, were both upregulated. Our findings suggest that BDNF does help PC-3 cells survive

during periods of stress and also indicate that IC sortilin is involved in BDNF transport in this cell line.

THE ROLE OF ENDOTHELIN CONVERTING ENZYME-1 IN HUMAN BREAST CANCER CELL INVASION. **Molly Watson***, **Amanda D. Williams**, and **Beth Conway**, Lipscomb University, Nashville, Tennessee. Endothelin Converting Enzyme-1 (ECE-1) is a membrane-bound metalloprotease that catalyses the conversion of inactive Big Endothelins into active endothelins (ET-1). Activation and over expression of ET-1 receptors have been indicated in breast carcinomas because of their biological significance in tumorigenesis, apoptosis, angiogenesis, invasion, and proliferation. Using Invasion Assays and the novel ECE-1 inhibitor, CGS 35066, invasion of MDA-MB-231 cells was significantly decreased. These results provide support for the role of ECE-1 in invasion as well as provide future targets for anticancer therapies.

BRAIN DERIVED NEUROTROPHIC FACTOR EXPRESSION DURING CELLULAR STRESS IN T-LYMPHOBLASTS. **Porter W. Maerz***, **Amanda D. Williams**, and **Jon Lowrance**, Lipscomb University, Nashville, Tennessee. Brain-derived neurotrophic factor, BDNF, is a major protein in the neurotrophin family. BDNF is important in neuronal growth and has been found to participate in differentiation, cell survival, and synaptic modulation. Recent data indicates have shown that BDNF also plays an anti-apoptotic role in multiple myelomas, non-Hodgkin's lymphoma, and activated T-Cells. In multiple melanomas, BDNF's anti-apoptotic effect was shown to be regulated by the transport/receptor protein Sortilin. These reports also indicate that BDNF may provide an escape from chemically induced apoptosis. Our investigation shows that the T-lymphoblast cell line CCL-119 does produce BDNF as both an mRNA product and an approximately 160 kDa protein. Sortilin is also shown to be found in CCL-119 cells through PCR. Both findings are previously unreported in the literature. In addition, we show that the CCL-119 cell line is sensitive to loss of serum deprivation, with cells undergoing apoptosis minutes after loss of serum.