

Abstracts of Presentations at the 2017 (127th) Annual Meeting of the Tennessee Academy of Science

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Poster Presentations

Agriculture

Building capacity for climate change education (CCE) and expanding research and learning opportunities in rural communities of Tennessee and Kentucky. **Rachna Tewari, Mark Simpson, Joey Mehlhorn, Naveen Musunuru and Brian Parr**, *The University of Tennessee at Martin, Martin, Tennessee (RT, MS, JM), and Murray State University, Murray, Kentucky (NM, BP)*. The U.S agricultural industry is a major player in the global market, and is affected by changes in climate which has implications for both domestic and global food security. Existing research reveals a disconnect between agricultural stakeholders and the wider climatological community in the U.S., which impedes the process of making informed decisions in response to climate related changes in agriculture. This USDA-NIFA funded project aims to bridge this gap in perception and understanding regarding climate change among stakeholders in rural communities, and to enhance educational curriculums in high schools and higher education institutes with a focus on climate change.

Assessing the demand of locally grown hops in Tennessee. **Jeremy Young**, *Tennessee State University, Nashville, Tennessee*. Hops are an essential ingredient in the beer making process. The overall goal of the study is to examine the demand for locally grown hops in micro-breweries throughout the state of Tennessee. Primary data was collected through telephone surveys for the study. Microbreweries were targeted in the study due to the use of specialty hops. Tennessee State University's Institutional Review Board's approval was achieved. Results confirm the assumption that there is a demand for both locally grown organic and inorganic hops in Tennessee. Most breweries are also willing to pay more for the locally grown organic hops.

Understanding Food Environment: Implication for Nutritional Security of Households around Food Desert Areas of Metro Nashville. **Omobilaji Omobitan*, Michael Crawford*, and Aditya R. Khanal**, *Tennessee State University, Nashville,*

Tennessee. USDA emphasizes on ensuring access to safe, nutritious, and balanced diet to everyone. Easy access to healthy food is a function of well-organized local food systems. Food retail environment and growth can be considered as an indicator of food demand in the area. This study aims to understand food retail structure, its pattern and growth in the Nashville metropolitan area. We used county business pattern data from US Census Bureau and zip-code level information for selected categories of food retailers under industries in NAICS; fruits and vegetable stores, food convenient stores, food groceries, farmer's markets and food restaurant establishments by different size were examined and compared. Additionally, we discuss results and implications in reference to the economic and demographic settings.

Entrepreneurship and innovation in agriculture. **Alyssa R. Counce*, Rachna Tewari, and Joey Mehlhorn**, *The University of Tennessee at Martin, Martin, Tennessee*. Entrepreneurship and innovation are vital to a college graduate's success as they directly impact one's ability to solve real world problems. In the business world today, having entrepreneurial skills is absolutely needed for progress. Graduates with experience in innovation and entrepreneurship will also gain control of future successes, as they are more adept in connecting with people. More problems are arising each day that only people with an entrepreneurial mindset can resolve. This mindset can be taught via classes, clubs, and competitions that allow students to cultivate ideas and products, as well as execute them. This project examines if agriculture graduates' perception about the importance of entrepreneurship and innovation in agriculture is affected by participation in, or exposure to entrepreneurship focused learning activities as part of their college experience.

Enhancement of switchgrass in degraded soil using amendment and inoculation strategies. **Ekundayo O. Adeleke* and E. Kudjo Dzantor**, *Tennessee State University, Nashville, Tennessee*. Bioenergy feedstock production on degraded land can serve as a means for modulating land competition for food versus energy. Experiments were conducted in the greenhouse using moisture replacement microcosms to

screen strategies for enhancing biomass productivities of switchgrass in a reclaimed surface-mined soil (RMS). Strategies included soil amendment with organic byproducts (poultry litter, paper mill sludge, and vermicompost), inorganic nutrients (nitrogen and phosphorus fertilizers), or a commercial preparation of mycorrhizae (AMF). Experiments were implemented in a 10 by 6 factorial design. After eight weeks of growth, inoculation of RMS with AMF produced the highest aboveground and total biomass (0.9g and 1.77g per microcosm container) at $p < 0.05$. These experiments allowed selection of treatments that are currently being tested in large pots for enhanced biomass production in degraded soil.

Food safety regulatory outreach and technical assistance for emerging entrepreneurs. **Aliyar Fouladkhah, Tennessee State University, Nashville, Tennessee.** A 2010-2015. Food Safety Modernization Act (FSMA) aims to ensure safety of domestic and imported foods by shifting the focus from response to contamination to preventive measures. Although FSMA is expected to appreciably enhance health of the public by further reducing the burden of the food-borne diseases, it requires extensive steps from employees and employers in the nation. As an example, development of validated control measures; conduct of hazard analysis, corrective actions, validation of existing processes, and biological soil amendment are some of the new requirements for many employees and entrepreneurs for the first time in the history of each corresponding industry. This presentation discusses the overview of FSMA with particular emphasis on regulatory requirements for emerging entrepreneurs and employees in various processing and production centers, undergoing new requirements.

Control of *Listeria monocytogenes* in ice-cream base using elevated pressure and natural antimicrobials. **Kristine Day*, Akiliyah Sumlin*, Kayla Sampson*, Abimbola Allison*, and Aliyar Fouladkhah, Tennessee State University, Nashville, Tennessee.** A 2010-2015 multistate outbreak associated with contaminated ice-cream with *Listeria monocytogenes* had drawn the attention of researchers and popular press to safety of ice cream products. This study investigated fate of *Listeria monocytogenes* during shelf-life of the product and utilization of an emerging interventions to eliminate the pathogen from ice-cream base. A natural antimicrobial in combination with elevated hydrostatic pressure (0 to 380 MPa) were investigated for decontamination of the inoculated product. While the bacterium did not ($P \geq 0.05$) proliferate appreciably during storage it remained detectable after two weeks of storage. A reduction of >3.0 Log CFU/ml was achievable due to synergism of heat, mild hydrostatic pressure, and natural antimicrobial that translates to $>9.99\%$ reduction of the bacterium.

Horticultural Therapy: A tool for improving sociability among adults with mental illness. **Ellen Wolfe, George Chitoyo, Ashley Akenson*, Sherrye Winnett, and Douglas**

Airhart, Tennessee Technological University, Cookeville, Tennessee. Over the last 40 years, HT has become recognized as an effective treatment modality for a wide range of populations of all ages and all types of disability. The purpose was to assess effectiveness of eight HT activities as therapy for adults with mental illness. Individual participation in group activities was recorded and compared for effectiveness at improving nine sociability goals via the sociability assessment instrument. *Building boxes, crafts, and harvesting* rated highest for attaining sociability goals. All sociability goals strongly positively correlated with time spent participating in HT activities: *appears out of delusions* and *demonstrates initiative* showed the highest correlations. Study results indicate that, when applied properly, horticultural activities can improve sociability among adults with schizophrenia and delusional behaviors.

Impact of thermal treatments on the texture characteristics of cooked sweetpotatoes. **Sochinwechi Nwosisi*, Ramasamy Ravi, and Dilip Nandwani, Tennessee State University, Nashville, Tennessee.** To develop successful market positioning, the characteristics desirable to consumers, for sweetpotatoes must be identified. Six sweetpotato cultivars (Hernandez, Japanese Purple, Murasaki, Orleans, Old Yellow and O' Henry) from the Tennessee State University organic research farm in Nashville, TN were processed thermally by baking, pressure cooking and open cooking. A texture analyzer was used to measure the textural characteristics. Objectives were to determine the impact of different thermal processing on textural characteristics of sweetpotatoes and to produce their texture profile analysis. Effect of different thermal treatments on textural characteristics of sweetpotatoes revealed a variation in the softness and hardness of the flesh and mouthfeel characteristics of different sweetpotato varieties. Different processing methods particularly thermal treatments would affect the consumer liking and eventually product acceptability.

Changing strategies for dealing with large online class sizes. **Jessica Crews-Garcia, Rachna Tewari, and Joey Mehlhorn, The University of Tennessee at Martin, Martin, Tennessee.** As online programs and courses become more popular on college campuses faculty are faced with large online sections. In the past, many of the online courses had limited enrollment (less than 25) in order to accommodate faculty and student interaction. As the numbers grow faculty must adapt their teaching style and development of online courses. Since most online course development requires a great deal of up front time it is important to design your courses with the targeted number of students in mind. Building a course for large online sections requires careful planning. Areas such as discussion board monitoring and synchronous sessions are hampered as the student numbers increase. Faculty must be able to adapt to student expectations of 24-7 access to the faculty member and class.

Molecular and functional novelty of animal unconventional interferon- ω . **Lauren E. Shields*** and **Yongming Sang**, *Tennessee State University, Nashville, Tennessee*. Type I interferons (IFNs) are innate cytokine mediators in immunological regulation. Analysis of IFN genes in 155 animal genomes revealed that pigs have the largest IFN family which consists of nearly 60 genes that encode for 7 IFN subtypes including multigene subtype IFN- ω . Evolutionarily defining porcine IFNs demonstrates that porcine IFN- ω subtype possesses novel features including: a multi-gene subtype displaying specific expansion in bats and ungulates, emerging isoforms with higher antiviral potency than conventional IFNs, cross-species high antiviral activity in mammalian cells, and potential actions through non-canonical signaling pathways. We focus on understanding IFN- ω evolutionary and functional diversity and optimization of novel antivirals. The data expands our understanding of unconventional IFN subtypes and their species-specific role in domestic animals, while simultaneously demonstrating that IFN- ω s exert broad and high antiviral activity.

What impacts student success on the veterinary technician national examination? **Jason Roberts**, **Scott Parrott**, and **Joey Mehlhorn**, *The University of Tennessee at Martin, Martin, Tennessee*. Completing an internship and national licensing exam can be some of the most difficult progression steps in any profession. The veterinary technology program at UT Martin has consistently evolved to include more training opportunities for student career development. In 2016, faculty started requiring all students to enroll in and complete an online VTNE preparatory class in addition to developing new innovative laboratory experiences for students. These high impact learning opportunities have greatly influenced student ability to pass the VTNE. Faculty continue to seek new opportunities to impact student retention of materials throughout the program. T-test results indicated several factors were significantly impacting student pass rates on the national exam. These factors included GPA, ACT, internship choice and specific curriculum science courses.

Fungicidal management of ambrosia beetles in ornamental nurseries. **Matthew Brown***, **Jason Oliver**, **Karla Adesso**, **Fulya Baysal-Gurel**, and **Paul O'Neal**, *Tennessee State University, Nashville, Tennessee*. Ambrosia beetles are important ornamental nursery pests. Fungicides were evaluated for their ability to reduce ambrosia beetle attacks and disrupt beetle colonization. Fungicide drench (Empress, Orkestra, and Pageant) and spray (Pageant) treatments and a non-treated check were evaluated for reducing ambrosia beetle attacks on flood-stressed flowering dogwood (*Cornus florida*), yellow poplar (*Liriodendron tulipifera*), or eastern redbud (*Cercis canadensis*) containerized trees. New ambrosia beetle attacks were recorded throughout the experiment. Beetle attacks were lower than non-treated checks in dogwoods treated with Orkestra and Pageant (spray) and yellow poplars treated with Pageant (drench). In redbuds,

none of the fungicide treatments were effective. No fungicide consistently reduced ambrosia beetle attacks. Additional research like rate optimization is needed, but results indicate these fungicides have potential for ambrosia beetle management.

Effects of nitrogen fertilizer rates and cultivar on yield and seed characteristics of winter canola in Nashville, Tennessee. **Kyle D. McGeary*** and **Jason P. de Koff**, *Tennessee State University, Nashville, Tennessee*. Alternative fuel sources are pertinent. This is particularly evident in recent transportation fuel price spikes (\$0.50 to \$0.60/gallon within a few days in Nashville, TN) caused by extreme weather events (i.e. Hurricane Harvey). Fossil fuels increase carbon dioxide in the atmosphere, increasing potential for extreme events. Winter canola (*Brassica napus*) is an oilseed crop favored for its high seed oil content. The oil can be used to produce biodiesel, therefore a potential alternative fuel resource. This study sought to identify effects of nitrogen application rates and cultivar type on seed characteristics of winter canola. Samples from the 2016-2017 growing season were analyzed for physical properties including yield, seed pod length, seeds per pod, mean seed weight, and seed density.

Botany

New occurrence data for state and globally listed plant species in Tennessee present in TTU's Hollister Herbarium (HTTU). **William Buck**, **Darrian Turner**, and **Shawn Krosnick**, *Tennessee Technological University, Cookeville, Tennessee*. The Paul L. Hollister Herbarium (HTTU) at Tennessee Technological University contains ca. 30,000 specimens, most of which have yet to be databased. Digitization efforts are being directed towards those taxa in the collection that are rare and endangered in Tennessee. In the current study, species native to the Blue Ridge Mountains, Ridge-and-Valley, and Sequatchie Valley ecoregions with conservation statuses S1-S3, G1-G3, or SH, GH (of historical significance) were identified following the 2016 Tennessee Natural Heritage Program Rare Plant List. Specimens were then databased and georeferenced using Google Earth and the GEOLocate web application and cross-checked against the BONAP database and UTK's Database of Tennessee Vascular Plant Occurrences. These data provide new county records and provide new insights into habitat preferences and historical distributions, thus contributing to statewide conservation efforts.

A quantitative analysis of a kale hybrid, *Tronchuda beira*, grown on a green roof, in a garden and in EarthBox® containers. **Caroline Glover*** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Urban agriculture is becoming more difficult to accommodate due to lack of green space. Extensive green roofs are becoming more common and used to grow a variety of plant types, especially heat and drought-tolerant species. Few studies have examined vege-

table growth on green roofs. In this study, a green roof, community garden, and EarthBoxes were used to compare growth of a kale hybrid, *Tronchuda beira* in different environments. Dry mass, height, rate of photosynthesis, level of herbivory, soil type, soil nutrient analysis, amount of sunlight, and soil and air temperatures were determined to note differences in the growth of the plants in the growing environments. Significant differences in plant growth are expected between the garden/green roof plots and the EarthBoxes, but no differences between the garden and the green roof plots. The overall significance of the study is to examine the possibility of using green roofs to expand urban agriculture.

Growth of a common pioneer species (*Salix nigra*) in a hypereutrophic environment. **Darya Klyuyenko*** and **James McAllister**, *Bethel University, McKenzie, Tennessee*. Carroll Lake was drained for dam repairs in 2014. In August 2016 a 1 by 68 meter transect through a lakebed willow stand (*Salix nigra*) documented one and two-year-old trees (GPS: 36.10026 - 88.48249). The average height, diameter breast height (DBH), and canopy size of 76 willows were 4.5 meters, 2.7, and 81.4 centimeters. The base diameter had appositional growth of 6.3 millimeters/yr to the radius. DBH correlated with height and could be used as a predictor of age. New willow saplings were not found, indicating possible intraspecific competition. The water table affected colonization of willows, which occurred where the water was farther from the ground surface. A transect elevation decline of 1.4 meters did not significantly affect growth characteristics. Willows experienced rapid growth in this hypereutrophic habitat with water table being an important controlling factor.

The hidden language of plants: Making sense of VOCs and plant defense. **Joshua C. Kraft*** and **Carol J. Baskauf**, *Austin Peay State University, Clarksville, Tennessee*. Plants' defensive strategies against herbivores include physical and chemical deterrents as well as attracting herbivore predators using volatilized organic compounds (VOCs). Sometimes induced defenses can be primed by VOCs released during herbivore attack, resulting in airborne messengers to "alert" neighboring plants to make defensive compounds. The vine *Passiflora incarnata* produces extrafloral nectar (EFN) to attract ants and contains cyanogenic compounds in its leaves to help ward off herbivores. We examined whether 24 hours of proximity to an herbivore-attacked neighbor (potentially releasing VOCs) induced greater EFN production and/or inhibited leaf consumption when "VOC-exposed" plants were attacked by herbivores and whether responses differed when attacked by a specialist vs. a generalist herbivore. No significant differences were found for leaf area consumed and EFN production between herbivore type or VOC exposure. Thus 24 hours of proximity to herbivore-attacked neighbors had no significant effect on induced defensive compound production in *P. incarnata*.

Cell and Molecular Biology

Novel etoposide drugs inhibit the growth of cancer cells in culture. **Priyanka Kumar***, **Joseph Deweese**, and **Chris Barton**, *Belmont University, Nashville, Tennessee (PK, CB)* and **Lipscomb University, Nashville, Tennessee (JD)**. Etoposide is a common chemotherapeutic compound and is currently used to treat a number of malignancies. Though effective, etoposide is associated with a number of secondary cancers, specifically acute myeloid leukemia. It is believed that the quinone metabolite of etoposide is responsible for this observation. Here, we show that novel analogs of etoposide, unable to be metabolized like the parent compound, show an inhibitory effect on cell growth in both colorectal and lung cancer lines. Cell cycle analysis shows an increase in sub G0 cell population of HCT116 cells and a decrease in S phase cell population of A549 cells. Our findings suggest that these etoposide analogs, due to their cell inhibitory effects, should be further studied as an alternative to etoposide. Further analysis of the mechanism of these drugs is needed to confirm their ability to specifically target topoisomerase.

The role of $\alpha 1$ -adrenergic receptor antagonists in the treatment of colorectal cancer. **Colin Cardwell*** and **Chris Barton**, *Belmont University, Nashville, Tennessee*. Colorectal Cancer (CRC) remains one of the main causes of cancer related deaths due to its common occurrence along with a poor late stage prognosis. Despite the progress achieved in developing treatment opportunities, the third most common form of cancer in Western countries is CRC. This study presents data suggesting that terazosin, an $\alpha 1$ -adrenergic receptor antagonist most commonly used in the treatment of hypertension or benign prostatic hyperplasia (BPH), is able to inhibit the growth of CRC cell line HCT116. We observed that HCT116 cells, following treatment with terazosin, show a significant increase for cell cycle arrest. However, the data did not show a significant increase of apoptosis and is independent of the p53 tumor suppressor pathway. Further research is necessary to determine if terazosin may work synergistically with another drug to be a viable option in cancer treatment.

The Effects of bromocriptine on the mobility of *Caenorhabditis elegans* worms induced with Parkinson's-like disease. **Midya Yarwis*** and **Nick Ragsdale**, *Belmont University, Nashville, Tennessee*. Having over 10 million people, worldwide, affected with Parkinson's makes it a very relevant topic of research. It is characterized by the loss of dopamine neurons in the brain, thus affecting a person's movement and cognition. Pharmaceuticals have provided treatments that slow down the progression of the disease, however only for a period of time as the body stops responding to these medications in time. Bromocriptine is a drug that has been used for diabetes and prolactin related issues, however it shows promising results for Parkinson's also. Research suggests that bromocriptine has neuropro-

tective abilities that can be used to protect dopaminergic neurons. In this research, bromocriptine was used to investigate its effect on movement activity of *Caenorhabditis elegans* worms induced with Parkinson's like disease through the use of 6-hydroxydopamine, a dopamine demolishing agent. Results suggest that bromocriptine neuroprotective effect does restore normal locomotion in Parkinson-like induced worms.

Investigating the potential role of *nsy-1* in response to an oxidative stressor. **Taylor Hodge* and Nick Ragsdale**, Belmont University, Nashville, Tennessee. *Caenorhabditis elegans* (*C. elegans*) serve as a model organism used to study the process of the loss of dopaminergic neurons due to the effects of treatment with 6-hydroxydopamine (6-OHDA). Research has shown that a mutation in the *nsy-1* gene, orthologous to the mammalian ask-1 MAPKKK and part of the highly conserved p38 MAP kinase pathway, plays a role in the innate immune response activated during oxidative stress. In this study, *C. elegans* were treated with 6-OHDA in order to determine whether or not there was a mobility shift in treated nematodes versus untreated nematodes in two strains, AU3 (*nsy-1* knockout) and wildtype N2 nematodes. It was hypothesized that the *nsy-1* gene knockout nematodes would exhibit a normal mobility shift assay after treatment with 6-OHDA.

Investigating the effect of the NMDA-type neurotransmitter glutamate on habituation in *Caenorhabditis elegans*. **Yasmine Telwar* and Nick Ragsdale**, Belmont University, Nashville, Tennessee. NMDA-type (N-methyl-D-aspartate) receptors are ion channel proteins that bind to specific glutamate neurotransmitters. This is uniform in both humans and *Caenorhabditis elegans*. The *nmr-2* gene codes for the glutamate receptor in *C. elegans*. Current literature links glutamate neurotransmitters to associative learning and memory formation. There has not been a connection made with forms of non-associative automatic learning. Habituation is considered the simplest form of learning, specifically non-associative, in vertebrate organisms. The mechanism is yet to be discovered. This experiment attempts to habituate both the wild type and *nmr-2* knockout *C. elegans*. A chemotaxis assay is performed to measure the effect of the manipulation. The hypothesis is: because of the inoperable NMDA receptor in *C. elegans* with the *nmr-2* k.o., they would not exhibit the same habituated behavior that the wild-type would. The results do not support the hypothesis.

Insight on aversive learning in *Caenorhabditis elegans* when introduced to *Bacillus thuringiensis* during reproduction and growth. **Brandi Duke* and Robert Grammer**, Belmont University Nashville, Tennessee. Bacteria serves as the primary food source for the microscopic nematode *Caenorhabditis elegans* (*C. elegans*). Due to the biodiversity of its natural soil-dwelling habitat, *C. elegans* encounter numerous bacteria strains – many of which are poor food sources or furthermore pathogenic. Ingestion of pathogenic bacteria

can be lethal for the nematode. However, *C. elegans* possess the remarkable capability to learn and recall environmental stimuli associated with food source quality. This defense mechanism greatly increases the nematode's chance of survival and reproduction. Though extremely pathogenic to *C. elegans*, *Bacillus thuringiensis* (Bt), has been shown to attract the nematode. The purpose of this work is to determine if *C. elegans* will modify its chemotaxis preference after onset exposure to Bt. A series of assays will be utilized to compare the chemotaxis behavior of *C. elegans* naive to Bt and *C. elegans* which have been previously introduced to the bacterium. This research is ongoing.

Isolation of Lysosomes in *Caenorhabditis elegans*. **Ryan T. Fox* and Robert T. Grammer**, Belmont University, Nashville, Tennessee. In this experiment, we aim to accomplish the isolation of lysosomes within the model organism *Caenorhabditis elegans*, a feat which has not been reported before. In an effort to obtain this isolation, a protocol used for the isolation of lysosomes in hogs adapted for *C. elegans* in addition to growth of the worms in liquid culture. This turned out to be successful. To ensure both viability and efficacy of the isolation, Acid Phosphatase assays were run and the absorbance at 405nm was taken to measure for lysosomal enzyme activity, comparing it to a standard curve of 4-nitrophenol. Additionally, we hope to accomplish finding the specific activity of the lysosomes by running protein assays of each of the samples obtained during the isolation.

In Search of a Simple Microfluidic Method for the Chemotaxis Assay. **Sherif S. Helmey*, Robert Grammer, and Krista McBride**, Belmont University, Nashville, Tennessee. The purpose of this study is to construct a simplified microfluidic model for the chemotaxis assay of *Caenorhabditis elegans*. We are investigating models with polydimethylsiloxane (PDMS) and glass, PDMS and bacteriological agar, and agar only. All models are based on a simple design with three bays and two channels connecting the bays in a single row. The current literature affords microfluidic devices that are highly specialized for measuring specific parameters of *C. elegans* while immobilized, swimming or mimicked crawling. The method we seek would allow the nematode to crawl or mimic crawling by swimming. We hope to find that our assay is faster, reduces dose dependent effects, and offers a better method for studying chemotaxis with small nematode counts.

Stable inheritance of olfactory imprinting in *Caenorhabditis elegans*. **Hope Kramer* and Robert Grammer**, Belmont University, Nashville, Tennessee. This study seeks to verify the ability of *Caenorhabditis elegans* olfactory imprinting to pass transgenerationally. *C. elegans* have been recognized to imprint on certain olfactory stimulants when exposed in the L1 life phase, presumably an epigenetic process. This imprinting results in an increased chemotaxis towards the stimulants as adults. Here, isoamyl alcohol is used as the

olfactory stimulant, imprinting on L1 worms. Bleach synchronized worms were used. Naïve worms were used to determine base-line attraction to isoamyl alcohol. Continuous generations are being imprinted with these same methods. Each imprinted generation will have 1, 2, and 5 subsequent generations of non-imprinted progeny tested to determine if these presumed epigenetic changes, which induce imprinting, can pass on transgenerationally.

Effect of inorganic vs. organic selenium compounds as a pre-treatment to oxidative stress caused by 6-Hydroxydopamine treatment in *C. elegans*. **AC Dowd* and Nick Ragsdale, Belmont University, Nashville, Tennessee.** Parkinson's disease has been linked to oxidative stress. Selenoproteins have been found to act as an antioxidant. Selenium is a micronutrient needed for normal bodily function that is incorporated into the selenoproteins. This experiment compared an inorganic form and an organic form of selenium in reducing the damage caused by a 6-hydroxydopamine (6-OHDA) oxidative challenge to the dopaminergic neurons. No difference was found in the mobility shift patterns between *C. elegans* treated with the two forms of selenium and 6-OHDA. It is assumed that both forms of selenium can be effectively incorporated into selenoproteins and thus contribute to antioxidant properties.

Single cell proteomics of long term aluminum treated switchgrass plants. **Mahesh Rangu*, Yingde Zhu*, Sarabjit Bhatti, Suping Zhou, and Theodore W. Thannhauser, Tennessee State University, Nashville, Tennessee and Cornell University, Ithaca, New York.** Aluminum (Al) stress causes a significant reduction in plant growth when grown in acidic soil and forms stunted root systems. Switchgrass plants were grown in hydroponic tanks filled with Al-treated and control solutions. After three months of aluminum treatment plants started showing physiological stresses such as declining photosynthetic activities and biomass. Root-tips were harvested and sectioned into 10µm sections. Diverse types of root-tip cells (Epidermal, cortex, endodermal cells) from these sections were isolated using LCM microscope. TMT labeling coupled with mass spectroscopy was used for the quantitative proteomic analysis between different cell types. Results from the proteomic analysis are currently being processed and will help to determine which proteins are being expressed in each type of cells.

Chemistry

The effects of weak reducing agents in the seed-mediated synthesis of gold nanorods. **Benjamin Ide*, Joshua Hinman, and Catherine J. Murphy, University of Illinois at Urbana-Champaign, Urbana, Illinois.** The scope of the Zubarev method of seed-mediated gold nanorod synthesis has been tested with regard to the reducing agent used. The goal of this study was to produce longer gold nanorods through the incorporation of weaker reducing agents than hydroqui-

none. The ability to easily make gold nanorods with higher aspect ratios than the predecessor would open new possibilities in fields such as photothermal therapeutics, drug delivery, biological imaging, and photothermal phase-change transitions.

Susceptibility of aromatic amino acids and peptides to chlorine dioxide and ozone. **Heather Deal* and Beng Ooi, Department of Chemistry, Middle Tennessee State University, Murfreesboro, Tennessee.** Chlorine dioxide (ClO₂) has been used for waste water treatment to degrade organic and inorganic chemical pollutants and also as a disinfectant due to its strong oxidizing capability. ClO₂ can also denature and degrade proteins. The purpose of this research is to determine the effects of ClO₂ and O₃ on the amino acids tyrosine, tryptophan, phenylalanine, and proline, a dipeptide Tyr-Phe and a tetrapeptide Endomorphin I. Samples were exposed to 5.45 mM ClO₂ for 30 minutes and the byproducts were analyzed using a High Performance Liquid Chromatography coupled to mass spectrometry (HPLC-MS) with electrospray ionization. O₃ treatment was carried out at 500 mg/hr for various time of 5, 10 and 20 minutes. For the ClO₂ treatment, the degree of susceptibility from the greatest to the least for amino acids are in the order of tryptophan > tyrosine > proline > phenylalanine, and then Endomorphin I > Tyr-Phe for peptides.

Recovery of silver nitrate from silver chloride waste. **James F. von Dollen*, Sofia Oliva*, Sarah E. Max*, and Jen Esbenshade, The University of Tennessee at Martin, Martin, Tennessee.** Silver chloride is a harmful byproduct produced in labs that has the potential to be recycled to silver nitrate. There are various methods that already exist to recycle silver chloride, but which method is ideal is unclear. By comparing the percent recovery, percent purity, cost, time required, facilities needed, and safety of the processes with two common methods chosen from literature an ideal method was determined. Further investigation was conducted on the by-product waste generated with each method and on the relative ease of the procedure. An ideal method was determined; however, information on both processes are provided so an institution can make an educated decision on which method to use based on their resources.

Silicon microspheres. **Savannah Metheny*, Bailee Barrett*, Benjamin Ide*, John Overcash, and Jen Esbenshade, The University of Tennessee at Martin, Martin, Tennessee.** This presentation will explore the potential biomedical applications surrounding controlled drug release and delivery of silicone microspheres synthesized using ultrasonic spray pyrolysis. A recently published method will be used to initially fabricate the silicone microspheres. The method will then be modified to manipulate the composition and morphologies of the microspheres. It has been shown that these microspheres can be loaded with a pharmaceutical agent with a controlled release. Varied composition and morphologies will be evaluated for change in the loading and

kinetics of release. These studies will lead to a better understanding of tuning the characteristics of the silicone microspheres for the application of interest.

Effects of chlorine dioxide on microorganisms. **Roderick Moore*** and **Beng Guat Ooi**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Chlorine dioxide has been used as effective disinfecting agents in food and health industries. This study investigates the biocidal effects of ClO_2 on *Escherichia coli* K-12 and *S. cerevisiae* cells in aqueous media. The focus of this research is to determine the concentration of ClO_2 and exposure time needed to kill 1×10^8 to 1×10^9 microbial cells. *E. coli* and *S. cerevisiae* were exposed for various time periods to different ClO_2 concentrations. The BacLight bacteria viability assay and fluorescence spectrometry technique was used to determine the ratio of live to dead cells in untreated and ClO_2 treated samples. Exposure to 1.91×10^{-3} M ClO_2 killed 3.96×10^8 *E. coli* cells in 1.5 hours. On the contrary, 1.67×10^{-2} M ClO_2 was needed to kill 1.45×10^8 *S. cerevisiae* cells in 3 hours. This shows that yeast cells are more resistant to the biocidal effects.

The rotational-vibration spectra of HCN from cigarette smoke using FTIR spectroscopy. **Samuel M. Hines***, **William G. Qualls***, and **Wilson K. Gichuhi**, *Tennessee Technological University, Cookeville, Tennessee*. The purpose of this contribution is to document a direct approach of obtaining experimental ro-vibrational spectra of HCN using a cigarette smoke. Although the ro-vibrational spectroscopy study of HCN-DCN is suggested as an extension to the classical HCl-DCI spectroscopy experiment in many physical chemistry laboratory textbook manuals such the Shoemaker et al., the implementation of such an experiment is usually hampered by the need to synthesize the toxic HCN gas. We present a HCN FTIR absorption spectra obtained from a cigarette smoke trapped in a 10 cm gas cell. Both the doubly degenerate bending (ν_2), and the C-H stretching (ν_3) vibrations are IR active and occurs at $\sim 712 \text{ cm}^{-1}$ and 3300 cm^{-1} , respectively. The ν_3 band gives rise to parallel transitions with P and Q branches that have a rotational fine structure. Future studies will focus on identifying more trace gases from cigarette smoke using a long-path FTIR technique.

The use of polarimetry and spectroscopic methods for the identification of an unknown terpenoid. **Victoria Lansdale*** and **Genessa M. Smith**, *The University of Tennessee at Martin, Martin, Tennessee*. An undergraduate laboratory exercise has been developed to help organic chemistry students better understand the utility of polarimetry and optical rotation in complex structure determination. Students will be expected to obtain spectroscopic data for an unknown terpenoid including: an IR spectrum, a proton NMR spectrum, a carbon NMR spectrum, and the optical rotation. Differences in the types of functional groups, numbers of carbon/proton signals, and optical rotation will

then be used to identify 1 of 8 possible unknowns. Optical rotation will be of particular importance because some of the unknowns are enantiomers of one another and cannot be identified without polarimetry data. Example spectra of one unknown will be presented along with preliminary classroom results.

A comparison of antioxidant content in supplements and common fruits. **Kaitlen Kisiloski*** and **Sarah S. Pierce**, *Cumberland University, Lebanon, Tennessee*. As people become more interested in living healthy lifestyles, they are more concerned about what they are eating. Antioxidants are of interest due to the many positive effects they can have on the body, including reducing the risk of disease, heart problems, and cancers. They have also been reported to reduce the effects of aging. Because of these benefits, new drinks and supplements have been produced claiming antioxidant powers. Ruby Reds® is a supplement that claims to have the same antioxidant content in one serving as five to nine servings of real fruit. In this project, the amount of antioxidants in Ruby Reds® was compared to blueberries, strawberries, and plums using the Folin-Ciocalteu assay. Understanding the amount of antioxidant content in these supplements will be important to the future health of individuals.

Blood alcohol and arson investigation using SPME fibers. **Chelsea Parker*** and **Robbie Montgomery**, *The University of Tennessee at Martin, Martin, Tennessee*. The use of SPME (solid-phase microextraction) fibers will also be investigated to determine the viability of using SPME fibers for alcohol and arson testing. SPME is a solid phase extraction sampling technique that involves the use of a fiber coated with an extracting phase. The fiber extracts different analytes from samples that can be in the liquid or gas phase. Analysis will be done by inserting the fiber directly into the solution/blood sample or by head-space analysis where the gas above the sample is collected while heating the sample to aid in vaporization. In both cases the fiber containing the sample/analyte is inserted into the GC injection port for analysis. The feasibility of using SPME fibers and the reliability of direct SPME injection versus head space SPME injection will be investigated. These results will also be compared to traditional blood alcohol and arson testing using a syringe.

Analysis of chemical and physical properties of regional honeys. **Bailee Barrett*** and **Abigail H. Shelton**, *The University of Tennessee at Martin, Martin, Tennessee*. Honey is a complex mixture that has inherent chemical and physical properties. These properties are believed to differ between geographical regions. A database of selected properties is being formed based on information collected from samples that have a known geographical origin. The geographical regions of interest are west Tennessee, middle Tennessee and southern Kentucky. The goal is to be able to propose a region of origin for an unknown sample based on trends established by the created database. To date, methods of

determining pH, color, moisture content and sugar content have been examined using a set of samples that have origins outside of the regions of interest. Preliminary results show an average moisture content of 17.9% and a pH of 3.93. Proton NMR, ultraviolet-visible spectroscopy, and fluorescence spectroscopy will be presented.

Multistep organic synthesis in introductory undergraduate organic chemistry laboratory. **Lane Brown*** and **Jozsef Devenyi**, *The University of Tennessee at Martin, Martin, Tennessee*. This research project was carried out to develop a series of organic chemical reactions that are adaptable as introductory sophomore organic chemistry laboratory experiments. The sequence of reactions started with the Diels-Alder reaction between furan and maleic anhydride to produce the anhydride adduct, which, upon hydrolysis, yielded the corresponding diacid. Esterification of the diacid with methanol provided the related dimethyl ester. The last step of the plan was bromination of the diester to produce the corresponding dibromo ester product. Each of the desired products was able to form, as supported by $^1\text{H}/^{13}\text{C}$ NMR and IR data, with the exception of the dibromo substance, which requires further changes of reaction conditions to achieve the intended dibromo product. The first three synthesis steps were repeated multiple times to ensure reproducibility.

Three component separation of an unknown sample. **James Crews***, **Shannon Belton***, and **Phillip Shelton**, *The University of Tennessee at Martin, Martin, Tennessee*. Many students in preparation for organic II laboratory have forgotten the basic techniques learned during organic I laboratory. The focus of this research has been to create an experiment, incorporated at the end of organic I laboratory, in which a student has to use the tools they have learned over the course of the semester, thereby refreshing long unused skills that will be useful in a synthetic-heavy organic II laboratory. The laboratory we are developing requires the student to separate three unknowns from a solvent and then analyze the separated compounds via IR, NMR, MS, and melting point. This will require the student to perform techniques such as acid-base extraction, recrystallization, distillation and column chromatography. Once the student has analyzed their products they will identify what their product is from a list of possible compounds. A series of three component mixtures has been compiled and tested for ease of separation.

Ecology and Environmental Science

Assessing biodiversity and leech (Hirudinea) parasitism of semi-aquatic turtles in an urbanized wetland in Nashville, Tennessee. **Laura Horton***, **Nicole Witzel***, **Brittany Hogan***, **Shawn Snyder***, **Jeronimo Silva***, **Brent C. Newman***, and **William Sutton**, *Tennessee State University, Nashville, Tennessee*. Aquatic turtles inhabiting a palustrine emergent wetland adjacent to Tennessee State University in Nashville,

Tennessee were examined for leeches as a component of a multi-year mark and recapture study. Leeches can serve as bioindicators in aquatic environments and are useful for determining the biological condition of aquatic ecosystems via species richness indices between parasite and host. Aquatic funnel traps were baited and deployed weekly from June – September 2016 to sample aquatic turtles. Each captured turtle was weighed, measured, sexed, marked, and examined for external leeches. All located leeches were removed and preserved for later identification. Turtle species captured during this study, included the Common Snapping Turtle (*Chelydra serpentina*), Stinkpot (*Sternotherus odoratus*), Spiny Softshell Turtle (*Apalone spinifera*), and the Red-eared Slider (*Trachemys scripta elegans*). The leeches that were collected from the turtles represented 3 different genera under phylum Hirudinea, including Batracobdella, Placobdella, and Helobdella, representing 7 different species. Collectively, these data are being used to understand parasite-host relationships and how patterns in leech abundance and richness vary throughout the active season.

Examining the presence of *Escherichia coli* and fecal coliforms at Percy Priest Lake in Nashville, Tennessee. **Hannah Forгани ***, **Chris Barton**, and **Matt Heard**, *Belmont University, Nashville, Tennessee*. *Escherichia coli* is a fecal coliform bacteria found in the intestinal tracts of endotherms. *E. coli* and other fecal coliforms are deposited into ecosystems when the intestinal lining sheds. *E. coli* presence can indicate the presence of other pathogens in the same environment. Government agencies regularly test ecosystems for the presence of these bacteria, however, they often overlook the sand that lines these ecosystems. When they test for these bacteria, they have set an abundance threshold. Recent research suggests sand could be a source of bacteria in these ecosystems so more studies need to be done to examine the differences in bacterial abundance between water and sand. In our study, we collected multiple samples at Percy Priest Lake and determined *E. coli* and fecal coliform abundance in sand and water. Our findings indicate that fecal coliform abundance is significantly higher in sand and most sand samples exceeded the abundance threshold.

Variations in arthropod diversity across green roofs differing in age and types of plant coverage. **Taryn G. Anderson*** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Green roofs are roofs in urban settings that contain foliage that can serve as habitats to support animal and insect diversity. Increased insect diversity contributes to a more biodiverse environment and has many positive effects on the greenroofs. This study examined the effect of two factors, age of roof and plant coverage, on the variation in arthropod diversity on green roofs. Pitfall traps under two plant types, grass and non-grass, were used to collect organisms in mid-September and in early November on three urban, campus green roofs. The organisms were identified to family level and diversity indices computed to assess variation in biodiversity. The expectation is that older roofs or roofs

with more plant biodiversity will support greater arthropod diversity.

Benthic communities at a tropical reef in the southern Caribbean after tropical storm Brett. **Madeline Woods***, **CalliAnna McDonald***, **Douglas Dorer**, and **Stanton G. Belford**, *Martin Methodist College, Pulaski, Tennessee*. Caribbean reefs face threats from anthropogenic effects, however natural disasters, such as tropical storms have only been revisited due to the re-emergence of category 5 hurricanes this year. We examined sites that were affected by tropical storm Brett in June 2017 to determine any change in benthic distribution. Line and point transects were used to obtain benthic community data, while $1 \times 1 \text{ m}^2$ quadrats determined sea urchin densities. At Salybia Bay (SB), mean percentage cover for hard coral (18.8%), soft coral (25.5%), and algae (19.6%) maintained consistent percentage cover as seen during the prior year. At Grande L'Anse (GA), percentage covers of hard coral (6.2%), soft coral (62.6%), and algae (9.0%) respectively. Sea urchins were significantly larger at low energy environments, which was consistent with results from 2016. Although results show consistent cover, these reefs may face future affects from storms, as they will continue to buffer coastlines against destruction.

Fertilization of green sea urchin, *Lytechinus variegatus*, negatively impacted by increasing temperature and acidity. **Cady L. Sliger***, **Virginia Fleer**, **James Wetzel**, and **Darlene Panvini**, *Belmont University, Nashville, Tennessee (CS, DP) and Gulf Coast Research Laboratory, Ocean Springs, Mississippi (VF, JW)*. Climate change is affecting such environmental impacts as ocean warming and ocean acidification. Previous studies have determined that these environmental changes can affect marine life. However, there is insufficient data to explain how these environmental changes affect the green sea urchin, *Lytechinus variegatus*. Due to its geographical location in the Gulf of Mexico, *L. variegatus* could be impacted to a greater degree by climate change. This experiment examined the effects of climate change-related factors on the fertilization success of *L. variegatus*. Experimental trials (23°C, 25°C, and pH 8.1, pH 8.3) were conducted in all combinations and compared to the control (21°C and pH 8.5). Percent fertilization decreased with increasing temperature and increasing acidity. This research provides additional information towards the goal of protecting marine life from the effects of climate change with a focus on fertilization success.

Decomposition of leaf litter on urban green roofs of different ages compared to decomposition in a community garden. **Latiara Jarvis *** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Decomposition of leaf litter is affected by a variety of environmental factors. While decomposition in natural areas has been examined, less is known about leaf litter decomposition on urban green roofs. As a human-constructed environment, the age of a green roof could be a determining factor affecting decomposition. This study

examined the decomposition rate of an herbaceous species, *Penstemon* spp, commonly grown on green roofs. Leaf litterbags were placed on three green roofs and in a community garden to study decomposition over a 6 month period. Decomposition on the green roofs occurred significantly faster than in the community garden. Age of green roof had less of an impact on decomposition rate. Examining ecological processes on green roofs can provide more information about the benefits of green roofs in urban areas to support biodiversity and support nutrient cycling.

The effects of exotic plant species on insect biodiversity within an urban temperate deciduous forest. **Christien Jackson*** and **Darlene Panvini**, *Belmont University, Nashville, Tennessee*. The invasion of exotic plant species can influence the arthropod biodiversity of terrestrial habitats. However, the impact on diversity is not fully known, especially in urban areas. This study examined levels of arthropod biodiversity in plots with varying amounts of native *Acer saccharum* and the exotics *Lonicera maackii* and *Ligustrum vulgare*. Arthropods were collected in plots dominated by exotic plants, plots with intermediate levels of exotics, and plots with no exotic plants in an urban forest. A combination of pitfall traps and branch beatings were used to collect specimens. Specimens were identified to family and diversity indices determined. Plots with high levels of exotic species are expected to have lower arthropod diversity and abundance, while plots with intermediate and low levels of exotic plants will have higher arthropod diversity. This research will provide information on the effects of exotic plants on arthropod abundance and diversity, with implications towards management.

The diversity of microbial communities on urban campus green roofs. **Terra'Lexus Roberts*** and **Darlene Panvini**, *Belmont University, Nashville Tennessee*. The use of green roofs is increasing as cities aim for environmental benefits such as reduction of energy use and storm water runoff. Green roofs also provide improvised ecosystems that allow a greater diversity of organisms to exist in urban environments. To examine the occurrence of microbes on green roofs on an urban campus in Nashville, TN, soil samples from three roofs and a community garden were collected. The green roofs varied in age and plant community structure. Soil microbial community analyses were determined using Biolog ecoplates. The occurrence of *E. coli*/coliforms, *Staphylococcus aureus*, and Enterobacteriaceae was assessed using 3M Petrifilms. Samples were collected in late September and early November to determine seasonal differences. The observation of microbial communities on green roofs can expand understanding of the role of bacteria and fungi in ecological processes such as nutrient cycling, plant absorption of nutrients, and animal and plant diversity.

The effects of exotic invasive plant species on pollinator diversity in an urban temperate deciduous forest. **Kylie C.**

Lawrence* and Darlene Panvini, Belmont University, Nashville, Tennessee. *Lonicera maackii* (bush honeysuckle) and *Ligustrum sinense* (Chinese Privet) are two common exotic invasive plant species in Middle Tennessee forests. These exotics can negatively impact bee and pollinator diversity and abundance in forests while also negatively affecting the forest as a whole by outcompeting native plants. This study looked at the effects of exotic plants on bee and pollinator diversity in an urban deciduous forest in Nashville, TN. Nine plots with nine collection traps each were established in areas varying from high exotic plant density to low/no exotics. Insects caught in the traps were collected within 48 hours and identified to genus. Preliminary results suggest that more pollinators were found in areas with an intermediate density of exotics and fewer pollinators in areas of dense exotic plants. The long-term implications are that exotic plants can impact natural areas by changing pollinator diversity which in turn can affect plant diversity.

Bat guild composition and habitat fragmentation in Costa Rica. **Justine Jusack* and LaRoy Brandt**, Lincoln Memorial University, Harrogate, Tennessee. Previous research has suggested that habitat fragmentation will alter bat guild composition. As forest fragmentation increases, the proportion of frugivorous bats in an area increases. Our objective was to compare the ratio of frugivores to insectivores/nectarivores from forest patches within a fragmented landscape. Using mist nets, bats were captured at the LaSuerte Biological Field Station, Costa Rica, within relatively large areas of undisturbed secondary forest, smaller fragmented and more recently disturbed forests, and a managed teak plantation. As the ratio of frugivores to insectivores/nectarivores in the younger (ratio = 3.75), more fragmented forest is greater than that in the older, less fragmented forest (ratio = 2.33), our data generally support our expectations. However, our sample size is not great enough to provide sufficient statistical power for further analysis (power = 0.19). Furthermore, observations from the teak forest also indicate that our sampling effort in this habitat was insufficient.

The potential of farm ponds as breeding habitat for amphibians. **Darrell W. England* and LaRoy Brandt**, Lincoln Memorial University, Harrogate, Tennessee. In the past, agricultural areas drained wetlands to increase land cover for crops and pasture which has resulted in a loss of amphibian habitat. On the other hand, constructed agricultural ponds may provide alternate breeding sites for many amphibian species. Our study objective was to evaluate the potential success of agricultural ponds in this context. Specifically, we compared the observed and estimated species richness of agricultural ponds to natural ponds. Overall, we found that the species richness across all farm ponds (9 species) was no different than that across all natural ponds (9 species). However, even though each of the farm ponds had all observed species present throughout the study, the natural ponds varied between sites in their species composition.

Other statistical results found that agricultural sites were consistent in their species composition across breeding seasons. Alternatively, natural sites showed less consistency across natural site location and breeding seasons.

Use of PIT tags in a mark-recapture study to assess survival and growth of the endangered freshwater mussel, *Epioblasma capsaeformis*, in the Powell River, Tennessee. **Victoria Long* and Agnes Vanderpool**, Lincoln Memorial University, Harrogate, Tennessee. Freshwater mussels are important species for the health of aquatic environments. Since 2012, state and federal agencies have partnered in an effort to restore viable populations of the endangered oyster mussel, *Epioblasma capsaeformis*, to its historical range in the Powell River, Tennessee. This study is designed to assess the effectiveness of PIT tags in monitoring survival and growth of juvenile oyster mussels stocked in critical habitat locations in the Powell River. Sixty PIT-tagged oyster mussels, age 24 months, were stocked on September 22. Recapture of tagged mussels and assessment of survival and growth will continue through early November 2017. Previous mark-recapture studies with PIT-tagged mussels have reported success in recapturing and monitoring juvenile mussels. Results of this study are expected to show that PIT-tagging is an effective way to monitor juvenile oyster mussels as part of an ongoing restoration effort in the Powell River.

Effects of rearing density on the growth of larval madtom catfish, *Noturus flavipinnis*, raised in captivity. **Maggie Singleton*, Agnes M. Vanderpool and LaRoy Brandt**, Lincoln Memorial University, Harrogate, Tennessee. Growth in total length of threatened larval madtom catfish, *Noturus flavipinnis*, sourced from wild-spawned nests and captive reared at varying densities was assessed over a ten-day period. Measurements of total length were collected pre- and post-growth period from a sample subset of each treatment. A two-way nested ANOVA revealed that the densities tested had no statistical effect on growth ($F = 1.31$, d.f. = 5, $p = 0.341$). However, the analysis did indicate there was a statistical difference in growth rates among the four nest sources, suggesting that there is a correlation between larval growth and genetic composition of the nests ($F = 8.76$, d.f. = 3, $p = 0.0196$). Evaluation of more nest sources is needed to validate the assumption of the potential for genetic influence in larval growth. Rearing at higher densities would help to determine if there is a threshold for density effects on growth.

An Analysis of the Efficiency of a Newly-Designed Grade-Control Structure in a first-order stream in northwest Tennessee. **Maria B. Gonzalez*, Arianna Howell*, Bradley Hartman*, Jeffrey Fore, and Thomas Blanchard**, The University of Tennessee at Martin, Martin, Tennessee, Murray State University, Murray, Kentucky, and The Nature Conservancy, Jackson, Tennessee. In-stream structures such as low-water bridges, box culverts, and grade-control structures may inhibit movement of small stream fishes. To

test the efficiency of a newly-designed grade-control structure, the West Tennessee River Basin Authority installed a series of these structures in a first-order, un-named stream near Reelfoot Lake in northwest Tennessee. To maintain gene flow between populations, these grade-control structures were designed to allow fish to move freely between different parts of the stream. To test the success of the structures, we conducted a mark-recapture study using visible implant elastomer (VIE) tagging to document the movement of fish through the structures. We marked 966 individual fish representing 16 species and found that 4 of the species were able to move through at least one of the structures. This study is important in determining if this particular design is effective in allowing stream fishes to move freely throughout the habitat.

Density and size of the beaded sea anemone (*Epicystis crucifer*) at a tropical reef in the southern Caribbean. **CalliAnna McDonald*** and **Stanton G. Belford**, *Martin Methodist College, Pulaski, Tennessee*. Caribbean reefs are dynamic and have an extremely diverse array of invertebrates, which may or may not be well studied. One such organism is the lesser known cnidarian, the beaded sea anemone (*Epicystis crucifer*), which is an organism that share densities with other invertebrates throughout coral reefs in the Caribbean. At intertidal located along the northeastern coast of Toco, Trinidad, we measured anemone densities using a $1 \times 1 \text{ m}^2$ quadrat. We also randomly selected individuals in each quadrat to measure oral disc area (ODA) using a hand-held caliper. Results showed that 22.7 individuals per m^2 were found in quadrats ($N = 17$). ODA average size was $621.3 \pm 467.6 \text{ mm}^2$ ($N = 55$), where the highest frequency was recorded for anemones with an ODA of 201-400 mm^2 . In general sea anemones provide homes for many invertebrate symbionts, and size and abundance of these anemones may be dependent on symbiont survival.

Detecting the presence and abundance of streamside salamanders (*Ambystoma barbouri*) in Middle Tennessee using environmental DNA. **Nicole Witzel***, **William Sutton**, and **Ali Taheri**, *Tennessee State University, Nashville, Tennessee*. The Streamside Salamander (*Ambystoma barbouri*) is an Ambystomatid salamander that occurs in Middle Tennessee. It is active during winter months when it emerges to breed in low-order, ephemeral streams. These animals are cryptic and can be difficult to detect using traditional survey methods. Environmental DNA (eDNA) could provide an effective method for detecting the presence of this species. Water was collected at 50 meter stretches of 17 streams across the *A. barbouri* range once per month for 6 months (December-May 2017). Stream segments were searched for all life-stages of salamanders using rock-turning and visual surveys. We used real-time PCR to quantify DNA using an *A. barbouri* species-specific primer and evaluated relationships between *A. barbouri* biomass at each site. Primary outputs from this study include a replicable eDNA approach to identify *A. barbouri* populations in Tennessee and

sampling guidelines for appropriate times to collect eDNA samples for *A. barbouri*.

Geology and Geography

Water movement habits in the Hatchie River Watershed. **Jonathan Wilson***, **Paula Gale**, and **Mark Simpson**, *The University of Tennessee at Martin, Martin, Tennessee*. In the Hatchie River Refuge Watershed, occasional flooding advances through the forested areas. Within the refuge you can find patches of debris washed into piles between trees with no real idea of where the water has come from or its general habits along the terrain. With the examination of the refuge from an aerial view point and the use of GIS data of the area we may create an accurate representation of the water's progression over the landscape. We collected data and with a combination of computer software programs we reveal the hidden pathways of water movement. These results help display a generalized development of water motion across the area and will further aid in the research of the Hatchie Refuge.

Soil climate analysis network (SCAN) in Middle Tennessee. **April D. Jones***, **Mark Simpson**, and **Paula Gale**, *The University of Tennessee at Martin, Martin, Tennessee*. Within Middle Tennessee, there are three farms that the Soil Climate Analysis Network (SCAN) has been conducted on. The farms are Allen Farm, McAllister Farm, and Eastview Farm. These farms are in the highland rim. Each farm has its own elevation, soil moisture content, precipitation, wind speed, geographic boundaries, and features. We are going to investigate the different aspects of each farm. I hope to discover new features and points to why one farm has less soil erosion, boundaries limitations, spatial features as well as the modeling of the different structures on the farms. I seek to determine what the soil moisture, geographic boundaries, and structures features will be labeled and categorized in the following years to come.

Groundwater flow in a karst aquifer at Tennessee State University. **Renas Barzanji*** and **Dafeng Hui**, with **Tom Byl**, *Tennessee State University, Nashville, Tennessee (RB, DH)*, *U.S. Geological Survey, Nashville, Tennessee (TB)*. Karst refers to carbonate bedrock with fractures, caves, sinkholes and complex hydrology and have complex hydrology. The objective of this project was to characterize the hydrogeology of the groundwater aquifer at Tennessee State University (TSU) research farm in Nashville. There are 9 wells drilled into bedrock (depth ranging from 175 to 250 feet below ground surface). We suspect fuel is in one of the wells and will use the triangulation method to determine the potential source. The transmissivity and storage capacity of the bedrock aquifer were also evaluated in an aquifer pump test. ($T = 317 \text{ sq ft / day}$; $S = 0.0002$ to $0.0003 \text{ gal/cubic ft}$). During the same aquifer pump test, measurements were taken and found that the cone-of-depression radiating from

the pumping well extended approximately 350 meters from the pumping well. The groundwater flow direction varied over the study period. The flow went to the west-southwest or north-northwest.

Observations about *Tremichnus* sclerobiont borings from the Bond Formation (Pennsylvanian), Charleston Stone Quarry, Charleston, IL. **Michael A. Gibson, Amy McLemore*, and Orana Paullus***, *The University of Tennessee at Martin, Martin, Tennessee (MAG, AM) and Weber State University, Ogden, Utah (OP)*. Two specimens of the sclerobiont trace fossil *Tremichnus* from the Pennsylvanian Bond Formation, Charleston, IL were studied for biotic interaction relationships with their host pelmatozoan crinoid stems and subsequent sclerobiont occurrences. *Tremichnus* was *syn-vivo* as indicated by ossicle swelling response from the host to multiple infestation sites. *Hederella* (currently assigned to either bryozoan or phoronid worm affinities) encrustations occur on ossicle swellings between *Tremichnus* borings along with pit-bases that probably belong to bryozoans. Taphonomically, where *Tremichnus* swellings had multiple borings, the excess ossification guaranteed articulated pelmatozoan stem segment preservation.

An unusual teleost from the Coon Creek Formation (Late Cretaceous), Western Tennessee. **Michael A. Gibson and Randall Seagraves**, *The University of Tennessee at Martin, Martin, Tennessee*. The Coon Creek Formation Lagerstätte preserves a diverse ecosystem of unaltered shelly invertebrates, swimming reptiles, and rare hadrosaur bone and teeth. Fish occur as isolated vertebra, teeth, and otoliths. In the dark, micaceous, shaley upper lithofacies we excavated a 3-part teleost with external soft-body form preservation (including portions of gills); the first record of any vertebrate "body" form from the Coon Creek Formation. The specimen lacks the jaw or teeth (possibly still buried within the specimen). Dorsal fin spines, collapsed into closed position, and few indistinct bone fragments are visible. Specimen has a flattened and deteriorated right side; left side body preserved by intact scales, which are thin, ctenoid (small spines on edges), semicircular, in overlapping position in lines, and still flexible.

Geomicrobiology and geochemistry of Karst Aquifer at Tennessee State University. **Darrius Lawson* and DeEtra Young, with Tom Byl**, *Tennessee State University, Nashville, Tennessee (DL, DY) and U.S. Geological Survey, Nashville, Tennessee (TB)*. TSU's research farm has 4 research wells with casing extending through 40-50 feet of regolith and open borehole another 200 feet into limestone. The wells are within close proximity of each other (20-hectare area), yet have very different water chemistry (e.g., aerobic, anaerobic, sulfide rich, iron rich). The objective of this research was to characterize the geochemistry and microbiology of the water associated with each well. Sulfide concentrations ranged from 3 to 127 mg/L in the sulfur waters. The pH ranged from 6.8 to 7.3 for all the wells Sulfur-reducing bacteria, sulfur-

oxidizing bacteria, iron-related bacteria and heterotrophic aerobic bacteria were plentiful in the groundwater. Understanding the geochemistry and geomicrobiology of the two systems provides insight into the biogeochemical cycles in the aquifer.

Layer-parallel-shortening strain: a key to the Sevier-Laramide deformational sequence in the Tendoy Range, southwestern Montana. **Christopher D. Loyacano**, *The University of Memphis, Memphis, Tennessee*. The Little Water syncline and Timber Butte anticline are complex structural features located within the Dixon Mountain quadrangle in southwestern Montana. The region containing the quadrangle has experienced two separate structural events which caused deformation that overlaps spatially and temporally: the Sevier Orogeny (140 – 50 Ma) and the Laramide Orogeny (75 – 35 Ma). This study utilizes a method of determining layer-parallel-shortening (LPS) strain directions based on careful analysis of specimens containing visible strain indicators, then placing that LPS strain within the larger context of regional structural features to determine which orogenic stress field first affected the study area. Thus, a detailed analysis of the Little Water syncline and associated Timber Butte anticline can be used to help in developing an accurate deformational timeline of the surrounding region.

Health and Medical Science

The role of DYRK1A inhibitor on tau phosphorylation. **Emily Rice*, Hyonson Hwang, and H. Dawn Wilkins**, *The University of Tennessee at Martin, Martin, Tennessee*. Alzheimer's disease (AD) is the most common form of dementia in the world and it is characterized by the presence of β -amyloid plaques and neurofibrillary tangles (NFTs). It has been reported that NFTs are intracellular insoluble aggregates of hyperphosphorylated microtubules associated protein tau and other proteins. The dual-specificity tyrosine phosphorylation-regulated kinase-1A (Dyrk 1a) is a protein that phosphorylates the amyloid precursor protein and tau and thus represents a link between two key proteins involved in AD pathogenesis. The purpose of this study was to examine the effect of DYRK1A antagonist (Harmine) on tau phosphorylation. Mass spectrometry-based phosphoproteomics were performed *in-vitro* and *in-vivo* samples and we detected 41 and 32 phosphorylation sites respectively. Among those, nine sites were analyzed for quantification and there was an average of 2.3 folds decrease with Harmine treatment. The results of this study suggest that targeting DYRK1A could be a new viable therapeutic approach for AD.

Amodiaquine, an anti-malarial compound, inhibits the growth of epithelial cancer cells in culture. **Bailey Bergmann* and Chris Barton**, *Belmont University, Nashville, Tennessee*. Cancer is currently the second most common cause of death

in America, so it is vital that research continue in order to effectively treat those affected by this disease. Amodiaquine is a drug with anti-inflammatory properties that is typically used to treat patients with malaria, but it has also been shown to kill human melanoma cells grown in culture. Whether amodiaquine is effective in other cancer types is currently unknown. To explore this, we used colorectal and lung cancer cells as a model to test whether amodiaquine is effective as an antiproliferative drug. Our data show that amodiaquine exposure results in a significant decrease in mitosis and a significant increase in apoptosis in all studied cancer cell types. Further analyses are needed to identify genes that are important for cellular response to amodiaquine.

Lycorine hydrochloride induces a proliferative arrest in colorectal cancer cells. **McKenzie Roberts* and Christopher Barton**, Belmont University, Nashville, Tennessee. Alkaloids are nitrogenous compounds extracted from plants and animals that have demonstrated the ability to inhibit the growth of cancer cells. One type of alkaloid, lycorine hydrochloride, has halted growth in multiple cancer types and has acted synergistically with other compounds, but its effects on colorectal cancer are unknown. We investigate whether lycorine hydrochloride presents antiproliferative effects on colorectal cancer. We show that lycorine hydrochloride promotes cell cycle arrest in colorectal cancer cells in culture. Alternatively, we show that lycorine hydrochloride does not have synergistic effects with the commonly used chemotherapeutics, 5-FU and etoposide. Our data indicates that lycorine hydrochloride could be utilized as a possible compound in treating colorectal cancer and produce better effects when used without other chemotherapeutics

Biofilm formation and decontamination of wild-type and pressure-stressed *Cronobacter sakazakii* and *Salmonella* serovars. **Abimbola Allison*, Shahid Chowdhury, and Aliyar Fouladkhah**, Tennessee State University, Nashville, Tennessee. With as high as 80% of all bacterial infections associated with biofilms, aggregate cells are the predominant physiological mode of bacterial proliferation in clinical settings. Two historic outbreaks of *Cronobacter Sakazakii* associated with infant formula in Memphis and Knoxville in 1988 and 2001, respectively, and 2016 infection episode of the bacterium associated with a premature infant in Pennsylvania had brought increasing attention in endeavors for understanding ecology and epidemiology of the pathogen. The current study discusses the growth of two pathogenic species on an abiotic surface and validates a decontamination intervention against wild-type and pressure-stressed phenotypes of the bacteria. Over 4.0 log CFU/cm² multiplication ($P < 0.05$) of the bacterial biofilms were observed with decontamination intervention more efficacious ($P < 0.05$) on earlier stages of the aggregate cells relative to mature biofilms.

Students, faculty, and staff feedback concerning campus dining for vegetarians. **Marcy Kaufman* and Terra L. Smith**, The University of Memphis, Memphis, Tennessee. Vegetarian and vegan diets are becoming a popular diet among the United States population. This mix-mode study investigated the perceptions of vegetarian dining on the campus of the University of Memphis by students, faculty, and staff. Ninety-six individuals completed the survey and 5 participated in the focus groups from Fall 2015 and Summer 2016. The study's data was statistically analyzed using the Qualtrics program. The focus groups were audio-recorded and coded according to policy, general and structural features, and menu item changes. Participants stated several times the frustrations of finding vegetarian options on campus due to lack of proper vegetarian-friendly policy, pricing, and healthier vegetarian options. In conclusion, even though the study results support the hypothesis of a negative perception of vegetarian dining and options by students, faculty, and staff on campus, the participants were able to find and purchase health vegetarian foods through savvy and creative means.

SEM study of bullfrog palates exposed to electronic cigarette (ECIG)-generated aerosol vs conventional cigarette smoke. **John M. Nelson*, Stan.C. Kunigelis, and Dominic L. Palazzolo**, Lincoln Memorial University, Harrogate Tennessee. Three groups of bullfrog palates ($n=3$ /group) were used: unexposed (control), and aerosol- or smoke-exposed. Peristaltic pumps transported 45-puffs of aerosol or smoke into exposure chambers containing excised palates, which were subsequently processed for SEM. Aerosol-exposed palates appear caked with material that is likely the deposition of puffed aerosol. This material has a trabecular-like appearance obscuring underlying glandular pits and weighing down cilia; consequently, making the epithelial layer appear thicker. Smoke-exposed palates appear littered with debris, but glandular pits are still visible; consequently, the epithelial layer appears thinner. Cilia are present in some areas of smoke-exposed palates while devoid in others. These results indicate that smoke-exposed palates exhibit more disruption of the epithelial layer, as seen by the accumulation of debris (presumably exfoliated cells), loss of cilia and thinning of the epithelium. Aerosol-exposed palates exhibit significant precipitation of aerosol, as evidenced by thickening of the epithelium and weighing down of cilia.

The effects of an antidepressant, Bupropion, on the chemotaxis of nicotine-treated *Caenorhabditis elegans* towards an attractant. **Sargoel Rezanejad* and Robert Grammer**, Belmont University, Nashville, Tennessee. Nicotine is a parasympathomimetic stimulant that crosses the blood-brain barrier in humans and binds to cholinergic receptors in the brain, impairing cognitive functions. Lately, nicotine antagonists such as antidepressants have been shown to reduce the effects of nicotine addiction and induce cessation. One such pharmaceutical, Bupropion, does so by blocking the nicotinic acetylcholine receptors in the brain, promoting

nicotine suppression in humans. In this study, we will investigate the effects of nicotine and an antidepressant on the chemotaxis of *C. elegans* towards an attractant. The optimal concentration of nicotine will be found by a dose response assessment and assays will be done with nicotine treated worms to see if nicotine impedes their chemotaxis to the attractant. Finally, we will do assays with Bupropion treated, nicotine-treated worms to see if the pharmaceutical will reduce the effects of the nicotine and improve the nematodes' chemotaxis towards the attractant.

History of Science

Role of Archibald Belcher in establishing the Tennessee Academy of Science. **Hunter D. Hudson*** and **Martin V. Stewart**, Middle Tennessee State University, Murfreesboro, Tennessee. Archibald Belcher was the first professor of physical sciences at Middle Tennessee State Normal School (MTSNS), and he made several key contributions to the Tennessee Academy of Science (TAS) as well as to MTSNS. The purpose of this project is to record the detailed history of his contribution to the Academy through an exhaustive review of archival sources in the Tennessee State Library and Archives, those published in the *Journal and Transactions of the Tennessee Academy of Science*, and the pioneering work of James Corgan. These contributions include holding various offices on the Executive Board, presenter at TAS meetings, and member and chair of several committees. Without the contributions by Archibald Belcher, MTSNS would not have been involved in scientific conversation with established universities through the activities of the Academy. Support from the Undergraduate Research Council of the College of Basic and Applied Sciences at MTSU is gratefully acknowledged.

Microbiology

Kinetics of progression of pathogenicity of *Caenorhabditis elegans* in response to *Bacillus thuringiensis*. **Dana L. Cornwell*** and **Robert Grammer**, Belmont University, Nashville, Tennessee. The purpose of this experiment is to determine the kinetics of pathogenicity of *Caenorhabditis elegans* in response to *Bacillus thuringiensis*. To determine the kinetics, *C. elegans*' activity and rigor were observed after being exposed to *Bacillus thuringiensis* for predetermined amounts of time. To date, *C. elegans* have shown increased rigor after being exposed to the *Bacillus thuringiensis* for 9 hours, and a significant number of *C. elegans* become completely inactive or die after 15 hours of exposure. In addition, there is a 100% lethality rate of *C. elegans* in response to *Bacillus thuringiensis* after 27 hours, in agreement with published values. The Nomarski microscope will be used to confirm that the onset of pathogenicity did

not occur in the intestinal tract before worm death and increased rigor.

Synchronization of the life cycle of *Caenorhabditis elegans* and the correlation of worm age and worm death from the pathogen *Bacillus thuringiensis*. **Haley Hatfield*** and **Robert Grammer**, Belmont University Nashville, Tennessee. This experiment is seeking to find out if there is a correlation between the stage of the life cycle of *Caenorhabditis elegans* and the prevalence of death due to the toxicity of the pathogen *Bacillus thuringiensis*. In order to test this correlation, a method of synchronization of the worm's life cycle is required so that only one stage of the life cycle can be tested at a time. Two different methods of synchronization are being observed; the bleach wash method and the picking method. Once a method of synchronization is mastered, the pathogen, *Bacillus thuringiensis*, will be introduced to the worms at each stage of their life cycle (L1, L2, L3, L4), and the number of dead worms at each stage will be compared. Our hypothesis is that there is a correlation between the age of the worms upon introduction to *Bacillus thuringiensis* and the prevalence of death.

Catalase activity among clinical isolates of *Enterococcus faecalis*. **Hunter J. Crouse*** and **Linda K. Husmann**, The University of Tennessee at Martin, Martin, Tennessee. The Gram-positive bacterium *Enterococcus faecalis* is a common nosocomial pathogen. This organism is known to produce a variety of virulence factors and yet the mechanisms by which it causes disease are not well understood. Under specific conditions, *E. faecalis* produces hydrogen peroxide but, paradoxically, may also degrade the hydrogen peroxide using a catalase enzyme. We assayed eighty clinical isolates for catalase activity using the standard slide assay as well as a colorimetric assay. These isolates represent a variety of infection sites and geographic origins as well as variation in vancomycin susceptibility. We found that catalase expression is not consistently observed among clinical isolates and does not appear to correlate with the site of infection or vancomycin resistance or sensitivity. We hypothesize that isolates that produce hydrogen peroxide but also exhibit undetectable or limited catalase activity may be associated with infections characterized by greater inflammation.

Cloning and sequencing of bacteriophage WL2 isolated from Reelfoot Lake. **Caroline E. Williams*** and **Michael J. Kempf**, The University of Tennessee at Martin, Martin, Tennessee. Bacteriophage WL2, which infects motile cells of *Flavobacterium johnsoniae*, was isolated from Reelfoot Lake in northwest Tennessee. The objective of this research was to use a cloning and sequencing approach to determine genome sequence of bacteriophage WL2 to better understand the role of bacteriophage in aquatic environments. Single digests of genomic DNA were performed. The resulting DNA fragments were ligated into pBluescript KS+ and introduced into *Escherichia coli* DH5 α . From 120 plasmids, 130,152 nucleotides were sequenced and preliminary analysis has

identified predicted proteins from open reading frames. Database searches of these predicted proteins showed amino acid identity to bacteriophage DNA polymerases, peptidases, and hypothetical proteins from other *Flavobacterium* phage. The predicted proteins of these open reading frames and their identity to proteins in the database will be discussed. Additional sequencing and analysis will result in a better understanding of the genes and proteins found in bacteriophage WL2.

Investigating the use of quorum sensing molecules in the pathogenic pathway of *Bacillus thuringiensis* in *Caenorhabditis elegans*. **Brooke A. Pugsley*** and **Robert Grammer**, Belmont University, Nashville, Tennessee. *Bacillus thuringiensis* (Bt) is a spore-forming bacterium that is a pathogen of *C. elegans*. The route of pathogenicity is not completely known in nematodes, but previous studies have shown quorum sensing (QS), the idea that bacteria communicate through pheromones to gain information about the environment and other cells, plays an essential role in *B. thuringiensis*' infection of insects, after sporulation. More research is needed to fully understand the importance of QS. This study will use media believed to contain QS molecules from sporulated Bt to surround vegetative Bt, revealing if the bacteria can quorum sense in that stage of life. A growth curve has been created for Bt in enhanced liquid medium, indicating sporulation is likely to occur after hour 20 of growth. Sporulation production over time will be documented to allow media removal at the highest point of sporulation to be tested for pathogenicity in vegetative Bt.

Abiotic factors affecting the migration rate of cyanobacterial cells through sediment columns. **Cody Rasner***, **J.S. Metcalf**, **K. Rasner**, **R. Richer**, and **Darlene Panvini**, Belmont University, Nashville, Tennessee (CR, DP), Institute for Ethnomedicine, Jackson, Wyoming (JSM), University of Wisconsin Marinette, Marinette, Wisconsin (KR, RR). Cyanobacterial cells and their toxins are found in drinking water supplies obtained from groundwater aquifers. How the molecules travel through sediment, contaminating reservoirs of water, is less understood. Prior studies indicate the flow of cyanobacterial cells and the toxin microcystin through sediment columns over a 72-hour period. Aquifers in the Great Lakes region may be disproportionately affected by cyanobacteria if the flow rate through sediment is impacted by environmental factors related to mining, climate change, or agricultural activity that lead to acidification, rising temperatures, or eutrophication. In this study, the movement of the cyanobacterial cells is investigated under varying abiotic conditions. Six sediment columns were filled with natural sediment obtained from Lake Michigan and the flow rate of cyanobacteria measured under three varying conditions: pH, NPK, or temperature of the columns. All three of these abiotic factors had measurable effects on the migration of cyanobacterial cells through lake sediment.

Effect of ECIG-generated aerosol and conventional cigarette smoke on the survival of commensal oral bacteria. **Maxwell Smith***, **John Nelson**, **Giancarlo Cuadra** and **Dominic Palazzolo**, Lincoln Memorial University, Harrogate, Tennessee (MS, JN, DP) and Muhlenberg College, Allentown, Pennsylvania (GC). All surfaces of the oral cavity are covered by commensal bacteria, which act as a layer of protection from the external environment, including cigarette smoke and ECIG-generated aerosol. Experiments were designed to compare the effect of aerosol and smoke on the survival of four strains of oral commensal streptococci. The results indicate that E-liquid (+/- nicotine) has no effect on bacterial growth as indicated by growth curves. Exponential phase for all four species progresses from 2 to 6 hours post-inoculation, regardless of E-liquid addition. Exposure to ECIG-generated aerosol (+/- nicotine) has no effect on the CFU quantification on all species. In contrast, cigarette smoke dramatically reduces or completely abolishes CFU counts as well as colony size on all species. These results suggest that ECIG-generated aerosol has, at most, only a modest effect on commensal bacteria, but conventional cigarette smoke has a profound impact on the growth of oral commensal streptococci.

Sensitivity of O157 and non-O157 serogroups of Shiga toxin-Producing *Escherichia coli* to elevated hydrostatic pressure. **Akilyah Sumlin***, **Kayla Sampson***, **Kristine Day***, **Abimbola Allison***, **Shahid Chowdhury**, and **Aliyar Fouladkhah**, Tennessee State University, Nashville, Tennessee. Various serogroups of Shiga toxin-producing *Escherichia coli* including O157, O26, O45, O103, O111, O121 and O145 had been involved in an array of outbreaks associated with meat products. Statistics derived from CDC foodborne outbreak database confirms this concern, delineating 423 outbreaks associated with ground beef from 1998 to 2015. With recent improvements in commercial feasibility of high pressure processing units, the technology is gaining rapid acceptability across various sectors of manufacturing, thus requiring extensive validation studies for effective adoption. In context of randomized complete block design trials, this study investigates the effects of elevated hydrostatic pressure on reduction of wild-type and rifampicin-resistant variants of the above-mentioned seven serogroups of Shiga toxin-producing *Escherichia coli*. Wild-type and rifampicin-resistant variants of the pathogen showed comparable sensitivity ($P \geq 0.05$) for vast majority of tested strains indicating they could be used interchangeably in future challenge studies.

Physics and Astronomy

Further investigation on white dwarf BD+17°4708 variability **Jesse McGaha***, **J. Allyn Smith**, and **Douglas Tucker**, Austin Peay State University, Clarksville, Tennessee (JM, JAS) and Fermi National Accelerator Lab, Batavia, Illinois (DT). BD+17°4708 is a sub-dwarf F star which we have been examining using the Sloan Digital Sky Survey data. Due to

its nature as a standard star and questions of its variability having been raised, we have prepared an assessment of BD+17°4708 regarding its continued use as a standard star and current plans for further analysis.

Searching for variable stars in the field of Dolidze 35. **Jamin Welch*** and **J. Allyn Smith**, *Austin Peay State University, Clarksville, Tennessee*. We are conducting a study of the open cluster Dolidze-35. We have a data set which contains several nights and spans four years. One step of our survey is to search these data to identify candidate local standards and potential variable stars. We present early results of the variable search effort.

Modeling and analysis of CTIO 1.5m white dwarf spectra. **Deborah J. Gulledge***, **Douglas L. Tucker**, **J. Allyn Smith**, **William Wester**, **Jacob M. Robertson***, **Jack H. Mueller***, **Mees B. Fix**, **Gautham Narayan**, and **Pier-Emmanuel Tremblay**, *Austin Peay State University, Clarksville, Tennessee (DG, JS, JR)*, *Fermi National Accelerator Laboratory, Batavia, Illinois (DT, WW)*, *Michigan State University, East Lansing, Michigan (JM)*, *Space Telescope Science Institute, Baltimore, Maryland (MF, GN)* and *University of Warwick, Coventry, UK (PET)*. We present results to date on spectroscopic reductions of white dwarf stars from the CTIO 1.5m telescope in support of calibrations for the Dark Energy Survey, which is based in the Southern hemisphere to map galaxies and gather information on dark energy. Science requirements for the survey require a 0.5% uncertainty in color, driven by supernova science. The Dark Energy Survey relies on a calibration technique that uses white dwarf stars to set zero points. These white dwarf spectra are fit to model spectra at the same temperatures and surface gravities. Fits are done both by a WD modeling expert, Pier Emmanuel Tremblay, and by WD model fitting software created by Gautham Narayan. Fits from both are comparable and give similar results, which are then used to generate synthetic photometry. These synthetic photometry values are compared to the measured values from the survey to verify that the zero points are correct.

Measurement of the K_{α} doublet of Molybdenum by x-ray diffraction. **William Alexander*** and **Timothy Brady***, *The University of Tennessee at Martin, Martin, Tennessee*. We measure energy separation of the two characteristic x-ray emissions in the K_{α} doublet of Molybdenum using diffraction of x-rays that are scattered by a Lithium-Fluoride (Li-F) mono-crystal target. The two lines are so close in energy that they appear as a single emission line in most x-ray spectrometry measurements. It requires use of a high resolution equipment at and looking at higher orders of diffraction interference for a long time to see clearly the separated K_{α} doublets, $K_{\alpha-1}$ ($K_{\alpha 1}$) and $K_{\alpha-2}$ ($K_{\alpha 2}$) unambiguously. It was necessary to do the measurement over a long time (about 3 hours) because the count rate of the scattered x-rays decreases significantly with increase in the order of interference. According to our measurement the

wavelength separation of the K_{α} doublets is: $\Delta\lambda = (0.42 \pm 0.13)pm$. This is consistent with the literature value: $\Delta\lambda = 0.43pm$. And the corresponding energy separation, according to this measurement is: $\Delta E = (0.104 \pm 0.032)keV$

Fragment distribution in the NOAA-3 rocket explosion in orbit. **Arjun Tan**, **Almuatasim Alomari**, and **Marius Schamschula**, *Alabama A & M University, Normal, Alabama*. The NOAA-3 second stage Delta rocket was the first among several such rocket bodies to have exploded following the successful mission in placing its payload in orbit. The assessed cause of each of these explosions was the ignition of residual propellants left in the rocket bodies. In this study, we examine the NOAA-3 rocket body explosion by calculating the velocity perturbations of the fragments in the parent satellite's frame of reference. The scatterplots of the velocity perturbation components in three mutually perpendicular planes indicate that the rocket body exploded in the 'Octant model' of exploding tanks. The largest fragment or the main remnant acquired significant velocity perturbations which is counter-balanced by a group of six other fragments in the diametrically opposite direction. The angular distribution map of the fragments substantiates this conclusion.

Fragment distribution in the Nimbus-6 rocket explosion in orbit. **Arjun Tan**, **Almuatasim Alomari**, and **Marius Schamschula**, *Alabama A & M University, Normal, Alabama*. The Nimbus-6 second stage Delta rocket was the eight among several such rocket bodies to have exploded following the successful mission in placing its payload in orbit. In this study, we examine the Nimbus-6 rocket body explosion by calculating the velocity perturbations of the fragments in the parent satellite's frame of reference. The scatterplots of the velocity perturbation components in three mutually perpendicular planes indicate that the majority of the fragments headed in one octant of space in the forward, leftward and downward directions, which is consistent with an explosion of propellant tank in the 'Clam model'. The angular distribution of the fragments in a cylindrical projection map showing the locations of fragments having the largest and smallest velocity perturbations substantiates this finding.

Genesis of the Gabbard diagram in the fragmentation of a satellite in a circular orbit. **Arjun Tan**, **Robert C. Reynolds**, and **Marius Schamschula**, *Alabama A & M University, Normal, Alabama (AT, MS)*, and *STAR Dynamics, Hilliard, Ohio (RCR)*. The Gabbard diagram is widely used in satellite fragmentations in orbit. It is a plot of the apogee and perigee heights of the fragments against their periods. For a fragmenting satellite in a circular orbit it has the shape of an inclined 'X'. The data points lie above and below the arms of the X. The space between them, devoid of fragments consists of the 'forbidden zone'. The envelope of the data points has the shapes of hyperbolas with the arms of the X as the asymptotes. This study finds the equations of the hyperbolas and their asymptotes. It is shown that the horizontal extent

of the arms is a measure of the intensity of the fragmentation.

Science and Math Teaching

Sharing shared shelf science sea life in the classroom. **Stanton G. Belford**, *Martin Methodist College, Pulaski, Tennessee*. Teaching science without visual representations may result in steering students away from STEM programs. Visual representations explain complex concepts, especially if these are related to the biodiversity of organisms. The purpose of this research was to use Shared Shelf as an assignment, which incorporates an online library of freely accessible images from the Martin Methodist College marine biology collections for the Red Sea, Trinidad, and Key Largo, to assist with learning objectives. The objective was to use these collections to assist with learning specific science concepts, such as taxonomy, scientific names, and phylogeny. Students were asked to choose an organism to demonstrate how well they understood taxonomic features by placing eight required items into an 8 × 11 poster. Overall, students incorrectly misrepresented taxonomic groups related to family and species names. Shared Shelf is a valuable resource to assist in teaching specific scientific concepts related to taxonomy and phylogeny.

The effects of self-regulated learning on the exam grades of college science classes. **Morgan A. Robertson* and Donald Shaw**, *The University of Tennessee at Martin, Martin, Tennessee*. The purpose of this study was to evaluate the effect of self-regulated learning (SRL) processes on course unit examination grades achieved by college students. In this study, SRL was practiced by students who maintained a journal in the form of a spreadsheet which listed study habits matched to the days of the week on which the study habits were performed. Two-hundred and twenty-three students in undergraduate introductory Biology and Human Anatomy & Physiology courses were assessed on their performance on course unit examinations after each student either did or did not participate in the SRL process. Students in this study were also assessed on their perceptions of the SRL process by means of a survey that was devised by the researchers. Preliminary data analysis indicated that examination grades were significantly higher for students who kept a SRL journal in some class sections but not all.

Zoology

The effect of urban green roof size on the diversity and abundance of arthropods and mollusks. **Courtney L. Ankrapp* and Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Green roofs provide a valuable habitat to arthropods and terrestrial mollusks in urban areas that have

limited green space. Arthropods and terrestrial mollusks have been found colonizing green roofs of all types, even those with limited soil structure and plant diversity. Fifteen pitfall traps were established on three urban green roofs of different sizes (1 trap per 24 m²) and specimens collected 48 hours later. Traps were set up twice to maximize sample size. Plant diversity and coverage was similar among the three roofs. The expectation is that diversity and abundance of arthropods and the abundance of mollusks will vary in relation to green roof size. This research can indicate ideal green roof sizes in order to maximize diversity of these taxa in urban areas.

An inter- and intra-year comparison of bat activity and bat species richness monitored via acoustic survey at Reelfoot Lake in northwest Tennessee. **P. Blayne Judkins* and Nancy Buschhaus**, *The University of Tennessee at Martin, Martin, Tennessee*. Presently, bat populations are drastically declining in the eastern United States due to a deadly fungal disease that causes White Nose Syndrome (WNS). Therefore, documenting any fluctuations in bat species richness and bat activity is essential, especially in locations that bats might use for summer roosts, such as areas near large bodies of water where there are high levels of aquatic insect emergence. The focus of our study was to determine whether bat activity and species richness differed between data collected at the same site on Reelfoot Lake in 2012, 2015, and 2017 at similar times of year, as well as whether those measures differed between June and October in 2017. We used bat detectors to record bats, SonoBat v.4 for initial auto-classification, and manual vetting to assign final species identifications. We concluded that both inter-year and intra-year comparisons had significant differences in bat activity and/or bat species richness.

Bright-field and electron microscopy use in the identification of tardigrades. **Hope Johnson*, LaRoy Brandt, and Stan Kunigelis**, *Lincoln Memorial University, Harrogate, Tennessee*. As microscopic organisms that are capable of entering a reversible death-like state (e.g., cryptobiosis), tardigrades hold high interest in both societal and scientific communities due to their ability to survive in extreme conditions. Easily collected from moss, lichen, fungi, and soil samples, tardigrades can be isolated for biological study. Due to their small size, microscopy is needed to identify characteristics necessary for appropriate taxonomic classification. The objective of this research was to compare the utility of bright-field microscopy to that of electron microscopy in the taxonomic identification of tardigrades. Moss and lichen samples were collected from sites in southern Appalachia. Samples were hydrated for 24 hrs., examined using a dissecting microscope, and tardigrades present in the samples were collected. Tardigrade specimens were further examined using bright-field and electron microscopy. Imagery from both microscopy techniques were then used for taxonomic identification.

Is the salience of a sensory modality fixed or determined by the environment in a crepuscular-nocturnal hawkmoth? **William L. Kuenzinger***, **Seré C. Jackson***, and **Joaquín Goyret**, *The University of Tennessee at Martin, Martin, Tennessee*. It is well established that hawkmoths use visual and olfactory information during nectar-foraging. These moths rely on innate color and odor biases, but can readily switch preferences through associative learning, and thus adjust to the high variability of the nectar offer in nature. Stöckl et al. have shown diurnal moths exhibit a stronger reward association to colors than to odors, while for nocturnal moths' odors are more salient during the learning process. *Manduca sexta* is a crepuscular-nocturnal moth that forages under illuminances that vary within a range of 4-5 orders of magnitude. Through a series of training and testing trials under different illuminances, our experiments will evaluate whether this hawkmoth shows a fixed, innate sensory biases during learning, or if illuminance conditions can modulate the salience of the different sensory modalities.

Mechanosensory sensitivity in *Manduca sexta*. **Amanda Mayo***, **Jonathan Travis***, and **Joaquín Goyret**, *The University of Tennessee at Martin, Martin Tennessee*. Adult *Manduca sexta* are large, crepuscular/nocturnal hawkmoths that feed nectar. While hovering in front of a target flower, they extend their long proboscis and inspect the floral surface in search of a nectar reservoir. This inspection behavior has been shown to use mechanosensory (tactile) information, and proceeds using two stereotyped motor patterns. While on a smooth, flat surface, moths use a "tapping" behavior, which quickly switches to a back-and-forth "diving" behavior upon contact of grooved surfaces. Here, we set to use these distinct behaviors to better understand the spatial sensitivity of the tactile sense of the proboscis. As a first approach, we are offering moths 3D-printed artificial flowers of three different kinds: smooth, with grooves of 1 mm or with grooves of 0.1 mm. Evaluating the probabilities of triggering the diving behavior of the different flower models will allow us to begin to estimate the spatial sensitivity of the proboscis.

A survey of ticks (Acari: Ixodida) parasitizing reptiles from managed pine-hardwood forests of northwestern Alabama,

USA. **Brent C. Newman***, **William B. Sutton**, **T.J. Haltigan***, and **Yong Wang**, *Tennessee State University, Nashville, Tennessee (BN, WS) and Alabama A&M University, Normal, Alabama (TH, YW)*. Reptiles and amphibians were trapped and examined for ticks from May through August 2017 in 18 total forest stands treated with a variety of management treatments, including two levels of prescribed burning and three levels of thinning in the William B. Bankhead National Forest located in northwestern Alabama. Two tick species (*Ixodes scapularis* and *Amblyomma americanum*) were collected from six species of lizards (*Plestiodon fasciatus*, *Plestiodon laticeps*, *Plestiodon inexpectatus*, *Anolis carolinensis*, *Sceloporus undulatus*, and *Scincella lateralis*). Lizards parasitized by ticks occurred at all treatment sites, however, lizards parasitized by ticks were most abundant in prescribed burning and thin with prescribed burning treatments. Ticks were most commonly encountered on *Plestiodon fasciatus* and *Plestiodon laticeps* with peak infestations occurring in July. Our results indicate that lizards may play an important role in the life cycle of ticks of which forest management techniques may also influence this parasite-host relationship.

Is the winter abundance of Red-headed Woodpeckers related to acorn production in a bottomland hardwood forest in northwest Tennessee? **Bailey C. Kelso*** and **H. Dawn Wilkins**, *The University of Tennessee at Martin, Martin, Tennessee*. Red-headed woodpeckers (*Melanerpes erythrocephalus*) move from open habitats into bottomland hardwood forests during the winter. As part of their winter diet, they cache acorns in crevices found in dead branches. Our goal was to determine the annual abundance of Red-headed woodpeckers and correlate that with the annual acorn production. For the past six years, we conducted 3 min unlimited-radius silent counts at five points located 250 m apart along a trail. Each point was sampled twice a month during the fall. In addition, we established nine 50 m X 50 m plots parallel to the trail to identify oaks for annual acorn surveys. We used a visual method which consists of inspecting different parts of the crown and counting the number of acorns observed. While not significant, there was a weak, positive relationship between the total number of acorns counted and the mean number of Red-headed woodpeckers per point.