College of Natural Sciences and Mathematics

Presents the 1st Annual

URS @ NSM

UNDERGRADUATE RESEARCH SYMPOSIUM AT NATURAL SCIENCES AND MATHEMATICS

UWA
THE UNIVERSITY OF WEST ALABAMA

TUESDAY, MARCH 13, 2012

9:00 A.M. TO 2:00 P.M.

BIBB GRAVES, ROOM 109

Organizing Committee

Dr. Maydison Ginting

Dr. Yun Ho Kim

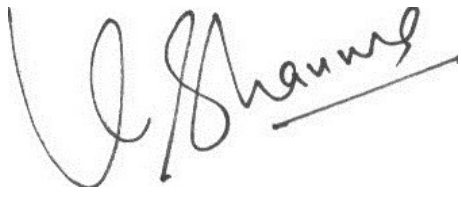
Dr. Mustafa R. Morsy

Dr. Ketia Shumaker (Chair)

Dr. Venkat Sharma, Dean (ex-officio)

Undergraduate Research in the College of Natural Sciences and Mathematics (NSM) is an integral part of student learning. Independent research under the direction of faculty mentors represents a unique learning opportunity for many students. Immersion into the techniques of academic research provides undergraduate students with a deeper understanding of their academic fields and prepares them for further success in their academic pursuits and later careers. NSM Faculty pay special attention to a student's individual interests and identity, and take pride in helping the research student concentrate his/her field of focus and refine the skills of scientific research.

The College sponsors the Undergraduate Research Symposium (URS@NSM, *usually held on Spring Assessment Day*), a celebration of the year's efforts in which the students present the results of their research activities to the broader university community. Undergraduates from all STEM (Science, Technology, Engineering and Mathematics) disciplines present their current and recent academic projects, showcasing the diversity of topics, approaches and interests. The Symposium also serves as a resource for other undergraduates. Those who are not yet engaged in these pursuits can learn how fellow students developed their intellectual interests, approached their current projects, and forged the faculty or community connections needed to achieve their success. Finally, URS@NSM is an occasion for students, faculty, staff, prospective students and alumni to witness how student projects enhance learning, support faculty members' own work, and also serve the greater community.



Dean Venkat Sharma

Events

8:00—9: 00 a.m. Poster setup

9:00—11: 00 a.m. Student presentation for Judges

11:00—1: 00 p.m. Public Viewing

1:00—1: 30 p.m. Award ceremony

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1) Extraction from *Zanthoxylum clava-herculis* Bark

Student Presenter: Zachary L. Riley
Faculty Mentor: Dr. Yun-Ho Kim
Abstract Category: Chemistry/Physics

Zanthoxylum clava-herculis is commonly called toothache tree since it was used by Native Americans as an anesthetic for tooth aches. *Zanthoxylum clava-herculis* tree bark has been suspended in 90% methanol for a week, filtered, further suspended for 4 days in chloroform, and purified using gravity filtration. After evaporation under vacuum, the extract was subject to flash column chromatography with which 3 fractions were yielded. The major crude product (2^{nd} fraction) was further subject to analysis and was identified. The fractions are thought to have neurological effects on mammals and will be tested on such in the future.

2) Commensal Bacteria on the Eyes of College Student Contact Wearers

Student Presenter: Tara K. Grayson
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

Bacterial loads are known to exist on human eyes, but how much? What kind of bacteria actually grow on a human eyeball? These are some of the questions that motivated this research. I conducted a five week study in which I collected weekly swabs from the right eye of eight college students. The eight students included four contact wearers and four non-contact wearers: two males and two females for each category. Each swab was streaked on a petri dish which was then incubated at 30^{o}C. After incubation, we counted all the different bacterial colonies on each student's petri dish for that week and recorded the data. Each week, in addition to having their eye swabbed, the students completed a stress test to determine if stress levels are correlated with bacterial growth. The potential roles of temperature and precipitation as major factors determining bacterial growth were also examined. Over the course of the five weeks, as the temperature continually dropped and precipitation increased the number of commensal bacteria increased. The bacterial loads ranged over two orders of magnitude between subjects. Molecular identification of the bacterial colonies is in progress.

3) Fish Mortality Associated with Tombigbee River

Student Presenter: Jon Tyler Newburn
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

Fish mortality was observed during a three week survey down the 500 nautical miles of the Ten-Tom Waterway and Tombigbee River from Pickwick Lake, at the confluence of the waterway with the Tennessee River, to Weeks Bay near the river's mouth in Alabama. The Tombigbee River system has gravity-fed navigation locks throughout the river, which result in high fish mortality. We collected fish carcasses down the length of the river system and identified them to species. Freshwater drum (*Aplodinotus grunniens*) suffered the highest mortality, and represented 22% of total carcasses. They were followed in abundance by blue catfish (*Ictalurus furcatus*) with 12% of total carcasses while both smallmouth buffalo (*Ictiobus bubalus*) and striped bass (*Morone saxatilus*) made up 10% of total carcasses observed during my research period. It is unclear whether differences in mortality represent different survival risks, or are simply correlated with abundance. Mortality rates are constantly changing in response to ship traffic, with higher trafficking causing higher numbers of fish death.

4) Ozone Stress Response in Northern Red Oak

Student Presenter: Dantria Grace and Christen Nelms
Faculty Mentor: Dr. Ketia Shumaker
Abstract Category: Biology

Northern Red Oaks (*Quercus rubra L.*) are ecological and economically important hardwood trees found in North America. These trees provide nesting sites for multiple organisms and are used for flooring, furniture, and pulpwood. The increase of exotic pests and diseases, combined with climate change, threaten the sustainability and regeneration of oaks. In the United States, ozone is responsible for approximately $500 million in reduced crop production each year. Ozone pollution places environmental stress on trees resulting in early leaf aging and loss of photosynthetic capacity. Currently, genetic databases are limited in providing the genomic resources to improve the sustainability of hardwood trees. To help solve this problem, we were trained for ten weeks at Penn State funded by the National Science Foundation. The focus of this study was to identify and examine the genes responsible for environmental stress responses in red oak seedlings when exposed to 30 days of ozone concentrations (150, 225, and 300 parts per billion) in greenhouses. Leaf tissue of the control and ozone-treated red oak seedlings were harvested and genetic material were isolated after the exposure period. To identify the plants' full genome, 454 sequencing technology was used. Cytoscape programming indicated genetic locations of ozone stress responses in various plant cell structures. Results showed that specific stress genes were activated as ozone concentrations increased. The results of this project are significant in helping the scientific community use innovative genetic tools to overcome environmental stresses that are threatening our forests.

5) Is *Curvularia* Thermotolerance Virus A Good Virus?

Student Presenter: Hayden Armuelles
Faculty Mentor: Dr. Mustafa R. Morsy
Abstract Category: Biology

Global warming is a well-known phenomenon in today's society. Because of this phenomenon, agricultural industries are losing billions of dollars every year due to crop damages caused by higher temperatures and drought. For example, in 2011, the State of Texas alone suffered more than $5.2 billion of damages in agriculture products due to heat and dry weather. With the steady increase in temperatures and human population, solutions in preserving crop loss are needed. One approach is to find and understand how wild plant species survive and flourish in unsuitable environments, and then adapt their survival mechanisms into crop plants. One such plant species, Panic Grass, *Dichanthelium lanuginosumi*, grows in Yellowstone National Park and survive temperatures of 65^{o}C of the geothermal soil. Panic grass survival mechanism is based on symbiotic relationship with a fungus, *Curvularia protuberate*, carrying a virus named Curvularia thermotolerance virus (CThTV). The fungal-viral symbionts provide thermotolerance not only to panic grass but also to crop plants including corn, wheat, watermelon and tomato. The research presented here examines the role of the fungal melanin in providing plants with protection needed against heat stress. We have observed that the virus reduces the fungal melanin present in the cell wall under stress conditions. Therefore, it allows movement of specific protective biochemicals from fungus to plants, providing them with thermotolerance. Understanding the interaction mechanism between plant, fungus and virus is important before using this system in crop production.

6) Plant Community Response to Oiling in an Alabama and Louisiana Salt Marsh

Student Presenter: Bobby H. Edwards III
Faculty Mentor: Dr. Lee E. Stanton
Abstract Category: Biology

In April 2010, the Deepwater Horizon released approximately 4.9 million barrels of oil into the Gulf of Mexico, which impacted many coastal ecosystems of the Northern Gulf Coast. Among those affected were intertidal salt marshes, which serve as critical nursery areas for many commercially important and ecologically sensitive species. This event provided a unique opportunity to assess how salt marsh plant communities respond to oil stress. We established permanent plots in oiled and non-oiled *Spartina alterniflora* marsh at Point Aux Pins (PAP) salt marsh in south Mobile County, Alabama. Information from NOAA's SCAT-Mobile Ground Observations on August 3, 2010 indicated light to moderate oiling on the eastern shore of PAP, as well as comparable non-oiled areas. Similar samples were collected from marsh locations near Port Fourchon, Louisiana. The SCAT-LA Ground Observations indicated heavily oiled locations in Timbalier Bay marshes beginning in May of 2009, with adjacent areas free from oiling. While both Louisiana and Alabama salt marshes are different in structure, a comparison of oiled to non-oiled sites in the two areas provided insight into how these two communities responded and recovered from oil stress. We measured above- and below-ground biomass, stem height and density of oiled and non-oiled *Spartina alterniflora* from January to December 2011. In general, our results indicate that oiling had no significant effect on above- or below-ground *Spartina alterniflora* biomass, stem height or density in both Alabama and Louisiana. Even though, our results do indicate that Louisiana marshes are deteriorating rapidly regardless of external anthropogenic stressors.

7) The Effects of pH on Cogongrass Stalk Length of Sumter and Bibb Counties, Alabama

Student Presenter: Jessica Elam
Faculty Mentor: Dr. Doug Wymer
Abstract Category: Environmental Sciences

Cogongrass was first introduced into the United States near Grand Bay, Alabama as packing material for oranges. It was later used as fodder for livestock. Since then, Cogongrass has become a major issue in Alabama, with nearly half of the counties in the state infested. Cogongrass devastates the land that it infests by outcompeting native plant species for space and nutrients. It also creates a fire hazard due to its ability to burn hotter and longer than native grass species. In order to better understand the effect of pH on Cogongrass development, a study was conducted in the spring of 2011. The study was performed in Bibb and Sumter counties in the State of Alabama. Habitats examined included disturbed forest land, roadsides, and logging areas. Plant stalk length, soil pH, soil moisture, and ambient temperature measurements were taken. Results indicate a strong correlation between pH level and Congongrass height.

8) Taking Flight on Tombigbee River

Student Presenter: Sherilyn Garner
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

Natural waterways are heavily utilized by many different bird species. Depending on the size and the geographical location of the waterway, the species of birds may vary. The Tombigbee River is one of the two major rivers that unite to form the short Mobile River and acts as introductory to the Mobile Bay on the Gulf of Mexico. It runs approximately 400 miles in length and surrounds much of the rural plain of Western Alabama and northeastern Mississippi, flowing southward. In this study, we surveyed the various types of birds on the Tombigbee River. Over the course of 15 days, while traversing nearly 400 miles of the river, I identified over 300 birds according to their physical appearance, flight, habitat and their distinctive calls. We organized the data according to the location where each bird was spotted. The results showed that many of the birds identified were found only in specific locations whereas other birds were located along the entire course of the river. The most abundant birds observed were the black vulture and the turkey vulture, which came as no surprise to me.

9) Discovery of Fungal Endophytes Associated with Environmental Stress Tolerant Plants in Alabama

Student Presenter: Robert Vaughn and Alexis McHale
Faculty Mentors: Dr. Mustafa R. Morsy
Abstract Category: Biology

Global climatic changes will have severe effects on human food security in the next few decades. Due to elevated temperatures generated from increased atmospheric carbon dioxide, the glaciers and ice caps are melting. Therefore, the sea level is rising, increasing soil salinity. Most crop plants are sensitive to high salt concentrations, which lead to significant yield reduction. However, some wild plants are naturally capable of survival under high salt levels due to symbiotic association with microorganisms, particularly fungi. For instance, the Stimpson Wildlife Sanctuary in Clark County, Alabama, has unique inland salt springs, where salt concentrations are not suitable to grow domesticated crops. In addition, some areas of the Black Belt soil surrounding the UWA campus has extreme alkaline or acidic soils, and varied salt levels. Nevertheless, there are wild plants growing in both areas. The research presented hypothesize that fungal endophytes associated with wild plants are responsible for plants salt tolerance. Thus, identification of these fungi will be invaluable for future crop productions in soils with high salt. We have collected salt tolerant plants growing under high salt levels from Stimpson Wildlife Sanctuary, and currently isolating and identifying fungal endophytes associated with these plants. After identification, we will test if these fungi can provide crop plants (tomato and wheat) with similar salt tolerance as in wild plants.

10) Comparison of Soil Bacteria Found in Oiled and Unoiled Communities in an Alabama Salt Marsh

Student Presenter: Alysia K. Shaw
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

In this study, bacterial communities found in the soil of two sites of a salt marsh were compared. One site was affected site by the BP oil spill and the other site was unaffected by the spill. Multiple sediment cores were collected monthly from the sites during 2011. Sediments samples were fixed in formalin, stained with DAPI, and counted using epiflourescent microscopy. Total bacterial counts from each site closely tracked one another and appeared to be inversely related to temperature. Significantly lower counts were seen at the oil impacted site during the months of April, May, and June. These results will be compared to other environmental parameters as an ongoing study of the BP oil spill.

11) Impacts of BP Oil Spill on Meiofaunal Communities in an Alabama Salt Marsh

Student Presenter: Cory Chance
Faculty Mentor: Dr. John N. McCall
Abstract Category: Biology

The Deepwater Horizon oil spill of 2010 has greatly impacted salt marsh ecosystems in the northern Gulf of Mexico ranging from Louisiana to Florida. These salt marsh communities act as nursery grounds and are beneficial to many species of fish and invertebrates. The oil spill provides an opportunity to study how these salt marsh ecosystems respond to stressors in their environment. Over an eleven month period, we measured meiofaunal densities in two separate locations at Point Aux Pins, Alabama, in Mississippi Sound. According to the National Oceanic and Atmospheric Administration, the eastern shoreline of Point Aux Pins was impacted by oil, while the western shore was not affected. We sampled meiofaunal communities at sites on the eastern and western shorelines over an eleven month period in 2011, and detected a direct correlation between nematode and harpacticoid copepod densities at each site. Densities of both nematodes and copepods were higher at the western site in January and February, but by March, when densities had increased greatly, the two sites did not differ significantly. Both nematodes and copepods rose to their greatest peaks in the late spring, but then crashed in the late summer and early fall. It remains unclear whether the observed patterns result from oiling impact. It is hoped that further research at the site will shed light on the factors affecting meiofaunal densities in this system. Support for this work was provided by the BP Sponsored Gulf of Mexico Research Initiative.

12) How Long to Brush? Bacterial Removal Efficacy of a Powered Toothbrush

Student Presenter: Katie LeMay
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

Microbes are present on the oral surfaces of human mouth at all times. The practice of teeth brushing has been known to remove some of these oral microbes and is considered one of the main components of personal daily hygiene. The question of how successful various teeth brushing tactics are may arise and should be answered accordingly. As the practice of dentistry has evolved into what it is today, the number of tooth brush and toothpaste types has increased to an almost insurmountable number. This project was designed to test one type of toothbrush and toothpaste to determine its success in reducing the number of oral microbes in a person's mouth. This was accomplished by collecting and quantifying the number of microbes that were knocked off of the teeth at thirty second intervals over the course of two and a half minutes of brushing.

13) Water Quality Assessment of Factory Creek in Sumter County, Alabama

Student Presenter: Terry R. Taylor and Richard Alsabrook
Faculty Mentor: Dr. Brian Burnes
Abstract Category: Biology

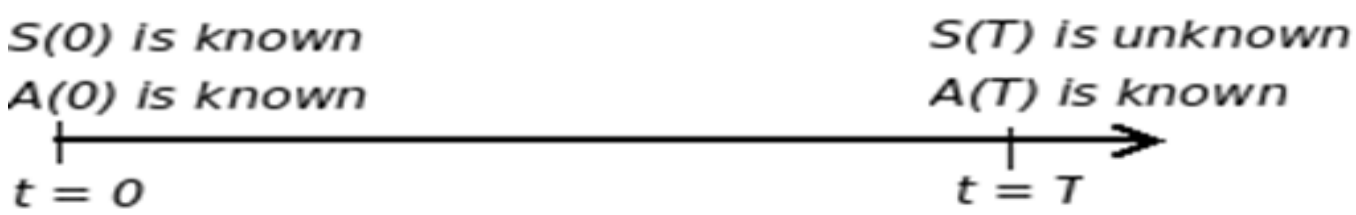
In 2001, the Alabama Department of environmental Management place Factory Creek on the Clean Water Act 303(d) list for failing to meet standards in four parameter (total nitrogen, total phosphate, turbidity, and dissolved oxygen) at sampling site 7. We have monitored these parameters monthly from June to December 2011 at site 7, as well as at upstream sites 41, 42, and 43 using EPA approved testing methods. Our results show that the standards for total nitrogen, total phosphate, and turbidity were frequently not met at all sites and the standard for dissolved oxygen has not been met at least once at two sites. Monitoring will continue for six more months.

14) An Overview of Financial Mathematics

Student Presenter: Katie Ford
Faculty Mentor: Dr. Maydison Ginting
Abstract Category: Mathematics

There are two types of financial assets, one risk-free and one risky security. Examples of risk-free assets are Certificate Deposits and Treasury Bonds. Stocks, commodities, and foreign currencies are considered risky security.

We consider the investment time horizon, t, where $t = 0$ is the present time and $t = T$ is the future time. If the price of a risk-free asset is A, then its current price $A(0)$ and future price $A(T)$ are known. However, for a risky asset whose price is S, the current price $S(0)$ is known but its future price $S(T)$ is unknown.



For a risk-free asset, if the interest rate is known, then the price at a future time T, $A(T)$, can be calculated. However, for a risky asset, $S(T)$ is a random variable (RV) with non-negative values defined on some probability space. In this case, $S(T)$ is a (measurable) real function

$$S(T):\Omega \to \Re$$

We consider $S(T)$ to be normally distributed random variables (RVs) with a finite sample space. Hence, the possible values of the future's asset price $S(T)$ will occur, respectively, with probabilities. The expectation of the asset price at time T is then defined by

$$E(S(T)) = \sum_{n=1}^{N} S(t, \omega_n) p_n$$

We will introduce several risky assets such as Stock, Futures, and Options.

15) Development of Small Molecule Inhibitor of Aurora Kinase

Student Presenter: Richard J. Alsabrook and Zachary S. Nethery
Faculty Mentor: Dr. Xin Wu
Abstract Category: Chemistry/Physics

Aurora kinases, a small family of serine/threonine kinases, play a critical role in the regulation of mitosis and are frequently over expressed in human cancers. Three isoforms Aurora A, B, and C have been identified containing a very conserved catalytic domain and an *N*-terminal domain that vary in sequence and in length. Studies have shown Aurora A and Aurora B are up-regulated in many cancers including breast and colorectal cancers. In the last decade, the use of Aurora kinase small-molecule inhibitors as potential molecularly-targeted anticancer agents has been studied by many research groups. As a result, compounds with different inhibition profiles, VX-680/MK-0457, PHA-739358, MLN8054, AZD1152, SNS-314, have been identified and entered clinical trials for the treatment of cancers. Our research at NSM is to focus on the development of novel Aurora inhibitor with good activity and selectivity using structure based drug design. The initial work is to identify the initial structure of lead optimization. Dr. Philip J Hajduk and his co-workers reported a statistical analysis of kinomics screening data of 3800 compounds, 2000 of which have revealed structures, against 172 different protein kinases. We have chosen three potential targets for our synthesis based the following criteria: 1) the ease of synthesis, 2) fair to good activity against 2-3 different kinases and 3) no profile against Aurora. Our group is in the process of synthesizing the in-house lead compounds based on three selected structures. Here we present our structure based design strategy and lead optimization method.

16) RANKL Docking Studies: The Search for Alternative Therapeutics for Treating Osteoporosis

Student Presenter: Jared Self
Faculty Mentor: Dr. Heather M. McDonald
Abstract Category: Chemistry/Physics

Osteoporosis, the major metabolic bone disease, affects more than 10 million people in the United States and accounts for more than 1.5 million fractures per year. The complex of two proteins receptor activator of nuclear factor-kB (RANK) and its ligand (RANKL) play a key role in initiating bone resorption and has been suggested as a possible target for the development of therapeutics to treat osteoporosis. The research presented here aims to gain information towards the development of a small molecule that could block binding of RANK to RANKL and effectively slow bone resorption. Using the published X-ray crystal structure of the RANKL-RANK complex, key residues involved in RANK:RANKL binding were identified. Docking studies were performed using RANKL as the receptor and a peptide derived from the RANK loop involved in binding RANKL as the ligand. Results from the peptide docking studies will be used to guide the search for small molecules that have the potential to block the binding of RANK to RANKL.

[1] Liu *et al*. (2010) Structural and Functional Insights of RANKL-RANK Interaction and Signaling. *J Immunol.* 184 (12):6 910-9

[2] Ta *et al*. (2010) Structure-based development of a receptor activator of nuclear factor -κB ligand (RANKL) inhibitor peptide and molecular basis for osteopetrosis. *PNAS* 107 (37): 20281-6

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