

#1 - PREDATORY CHEMICAL CUES AFFECT GILL BLOOD FLOW IN LARVAL RINGED SALAMANDERS. Valerie Jones, Adam Crane and Alicia Mathis, Biology. Faculty Advisor: Dr. Alicia Mathis

The vertebrate fight-or-flight response in the presence of danger typically is characterized by both physiological and behavioral changes, which have been well-studied in humans. In nonhumans, many species have been shown to exhibit behavioral responses to perceived danger (predatory threat), but few studies have examined physiological responses. Larvae of ringed salamanders (*Ambystoma annulatum*) are aquatic and occupy woodland ponds where they are subject to heavy predation from various predators, including newts (*Nopoththalmus viridescens*). Larvae respond to chemical stimuli from newts with appropriate antipredator behavior, and we predicted that larvae would also respond to newt stimuli with increased blood flow in their gills. In a laboratory experiment, we exposed newly-hatched larval salamanders to either stimuli from newts, stimuli from nonpredatory tadpoles (*Lithobates clamitans*), or to a blank control. We then placed each salamander under a dissecting microscope and recorded the frequency of discrete pulses of blood flow in the gills. Salamanders increased blood flow when exposed to newt cues relative to tadpole or blank cues; increased cardiovascular activity is predicted as part of the fight-or-flight response. The bioassay used in this study may be useful for answering additional questions about predator recognition and other types of stress by larval salamanders.

#2 - RATES OF INFECTION OF *DERMACENTOR VARIABILIS* BY *BORRELIA IONESTARI* AND *BORRELIA BURDORFERI* IN SOUTHWEST MISSOURI. Richard Wells, Rhy Norton, Biology. Faculty Advisor: Dr. Jack Steiert

Ticks serve as vectors for the transmission of disease causing bacteria. *Borrelia burgdorferi* and *Borrelia lonestari* are the causative agents of two tick-borne diseases, Lyme disease and Southern tick-associated rash illness (STARI) respectively. The purpose of this study was to determine the rates of infection in *Dermacentor variabilis* (American dog tick) by these two bacteria species. The information can be used to establish the risk of tick attachment to humans. Ticks were collected from six counties in southwestern Missouri and stored in ethanol until processed. DNA was extracted from each individual sample and used in polymerase chain reaction (PCR) assay for the detection of *Borrelia* specific DNA. A nested PCR assay was performed that amplified a portion of the *flaB* gene sequence to identify *Borrelia* species. An infection rate of 2.7% by *Borrelia* species in *Dermacentor variabilis* was calculated from the assay results. DNA sequencing was performed on the purified PCR product to verify PCR results and identify the specific *Borrelia* species. Future studies are needed with larger sample sizes to more accurately determine the tick infection frequency by these two *Borrelia* species.

#3 - FERTILITY OF AN INVASIVE FRESHWATER SNAIL. Meghan Lenhardt, Biology. Faculty Advisor: Dr. John Havel

The Chinese Mystery Snail (CMS) (*Cipangopaludina chinensis*) is an aquatic invasive species that has invaded lakes and streams over a wide range of North America. Prior studies of other exotic species have shown that invasiveness and impacts are directly related to reproductive output. I studied reproductive patterns of CMS during summer 2010 in field and laboratory experiments in northern Wisconsin, where the species is particularly widespread. My dissections of 110 CMS indicated that fecundity (range 0-57 embryos) increased with size of the mother. I compared fertility of isolated CMS adults held in the lab (16 containers) and in the field (14 containers, split between macrophyte beds and the main channel). Twice a week over an 8-week period, I counted and removed offspring from each container. I later confirmed gender of the mothers by dissection. Females released live young over the entire summer (air temperature range 12-28°C), with a total of 6-38 live young per female. Statistical analysis indicated no significant difference (nsd) in fertility between the two field habitats and also nsd between the field and the lab, suggesting that future experiments can be conducted in the lab to mimic fertility in the field.

#4 - AN INVESTIGATION OF THE ROLE OF SIRTUIN PROTEINS IN PLANTS. Alexandra A. Erwin, Husham M. Syed, Katalin Pilinszky, Biology. Faculty Advisor: Dr. Laszlo Kovacs

Sirtuin proteins have attracted considerable scientific attention as presumed regulators of longevity in animals. Sirtuin homologues are also present in plants, but their role in plant cells is unknown. In other organisms, sirtuins are deacetylases which act on histones and other proteins to modulate genome stability, stress resistance, and energy metabolism. Resveratrol adds a higher level of complexity to plant sirtuins: it is known to activate sirtuin proteins in animals, but there is no information about its interaction, if any, with plant sirtuins. Our aim is to investigate the role of sirtuin proteins and resveratrol in plants. We obtained a cloned copy of the grapevine SIRT7 gene and cloned a member of the grape resveratrol synthase (ReSy) gene family. Each of these genes will be inserted individually into *Arabidopsis thaliana*. A cross of the two resulting transgenic lines will give us a double-transgenic plant. We cloned the ReSy downstream of an inducible promoter, so we can regulate the presence of resveratrol in the transgenics and determine if the co-occurrence of resveratrol synthesis and sirtuin expression results in a phenotypic change. We also constructed an N-terminal fusion of SIRT7 with a GFP gene to facilitate the subcellular localization of the SIRT7 protein in plants.

#5 - YEAST DYNAMIN IMPLICATED IN ENDOCYTTIC SCISSION AND THE DISASSEMBLY OF ENDOCYTTIC COMPONENTS. Brandon Tenay, Daobing Wang, Jeff Sletto, Biology. Faculty Advisor: Dr. Kyongtae Kim

Freshwater mussels are the most threatened animals in the US. Seventy species are federally endangered. We are propagating mussels for population restoration and for toxicology research. Mussel larvae are brooded for months within the female, and then are briefly parasitic on fish where they metamorphose to the juvenile stage. One important question is whether older larvae and juveniles that develop from older larvae are as healthy as younger larvae and juveniles. We tested old and young larvae of mussels by placing them on host fish, recovering the juveniles, and then observing duration of survival of juveniles. We inoculated 36 largemouth bass with larvae from six females. Three females had 5-mo old larvae, and three had 18-mo old larvae. We determined the proportion of attached larvae that metamorphosed, and then observed the survival of juveniles during starvation, as a measure of their condition. Older larvae were equally able to attach to the host, but were significantly less likely to successfully metamorphose ($p=0.016$, T-test). The time to 50% mortality (LT50) of starved juveniles was 25.5 days and was similar for juveniles from old and young larvae. These data suggest that older larvae are suitable for propagation and toxicology research.

#6 - THE POTENTIAL EFFECTS OF RESOURCE INPUTS ON SMALL ISLAND ECOSYSTEM DIVERSITY AND FUNCTION. Seth Cox, Biology. Faculty Advisor: Dr. Alexander Wait

Two or more ecosystems can be connected through flows of energy, nutrients and organisms where one system acts as a donor system and the other as a recipient system; for example riparian forests and streams or shore and marine systems. Such flows alter energy and nutrient budgets of the recipient systems (e.g., a stream) and can have substantial impacts on the populations of organisms in the recipient system (e.g., fish). Understanding the ecological impact of such flows between donor and recipient systems is essential in developing a management plan for conservation of natural resources. On ten satellite islands in the San Juan Island archipelago of Washington, I evaluated the impact of three inputs from outside the island ecosystem (where the island is the recipient of nutrients brought into the system by marine vectors) on soils, plants and invertebrates: (1) algal wrack and carrion washed ashore, (2) river otter excrement and diet scraps, and (3) Canada geese excrement (albeit the geese are not technically a marine vector). I collected soils, leaves from two species of herbaceous plants, beetles and isopods from each satellite island in areas categorized as: coastal, otter, goose and center (control areas), and analyzed samples for $\delta^{13}C$, $\delta^{15}N$ and %N as evidence of uptake and assimilation of nutrients from these sources. Soils exhibited higher %N and $\delta^{15}N$ in areas with high goose fecal input compared to the control areas or

coastal areas. The same pattern was evident in the plant and insect samples as well, although those had much greater variability. Similar results were found for soils, plants and insects in areas with otter fecal and scrap inputs, but the patterns were less distinct than they were in goose areas. Geese also appear to be significant sources of both Ca and P on these small islands. Samples from coastal areas did not show any significant impact of algal wrack or carrion on the $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and %N of soils, plants or insects, compared to controls. This study suggests that biological vectors such as otters and geese may have relevant impacts on the physiology and consequential population dynamics of plants and insects in the San Juan archipelago. How this influences the diversity and community structure of these islands will be the focus of future research.

#7 - THE EFFECTS OF PRESCRIBED FIRE IN OZARK FORESTS AND WOODLANDS ON SPRING EPHEMERAL SPECIES RICHNESS. Rachel Posey, Biology. Faculty Advisor: Dr.

Alexander Wait.

Spring ephemerals are plants that are essential for soil nutrient cycling and to early activity of insect pollinators. Spring ephemerals emerge and complete their aboveground growth shortly after winter ends and before trees leaf out. They affect soil nutrient levels by acting as a “vernal dam”. A vernal dam is so named because spring ephemerals retain or hold soil nutrients that might otherwise be lost from the ecosystem. Although they have minimal nutrient uptake in comparison to trees, their timing of activity could have a significant effect on nutrient loss from a system and nutrient storage as a whole. The richness of spring ephemerals in a forest system is, therefore, important to determine. In many Ozark forests prescribed fire is used to manage the system for wildlife; however, the effects of spring prescribed fires on spring ephemeral richness is not well understood. At the Drury/Mincy (DCA) Conservation area (where the MSU Bull Shoals Field Station is located) approximately 70% of closed forest area was been burned in 1991, 2001, 2003, and 2008. Other areas have not been burned for over 50 years (and act as controls). Other areas have been burned on a two-three year cycle since 1980 and act as reference areas. In this poster, I will present data from 2008-2011 on species richness of spring ephemeral as a function of history of prescribed fire. I will also present some general forest characteristics of the sites associated with burning history (e.g., leaf litter depth, overstory composition). In general, reference areas have the highest spring ephemeral species richness followed by recently burned forest, with unburned control forests areas having the lowest species richness.

#8 - VPS1'S INVOLVEMENT IN PROTEIN RECYCLING FROM EARLY ENDOSOME TO LATE GOLGI. Joshua Lukehart, Chad Highfill, Biology. Faculty Advisor: Dr. Kyoungtae Kim.

Protein trafficking and recycling involves the transportation of macromolecules into, between cellular organelles, and out of the cell. The trafficking is imperative for cell survival and growth. Vps1 (Vacuole Protein Sorting 1), a large GTPase, functions in proper sorting and trafficking of soluble vacuolar proteins, including carboxypeptidase A (CPY), from the late Golgi to the vacuole. We previously observed that yeast strains lacking Vps1 showed an accumulation of lipid vesicles in the cytoplasm when labeled with FM4-64 and we hypothesized that Vps1 is involved in vesicular trafficking from endosomal compartment to the late Golgi. Snc1, a v-SNARE required for membrane fusion to the target membrane, is a well-known marker that follows the endocytic recycling pathway, from the plasma membrane through the early endosome to the late Golgi and back to the plasma membrane. Snc1-GFP in wild-type cells followed the recycling pathway, whereas cells lacking Vps1 displayed more accumulated Snc1-GFP puncta in the cytoplasm. In the near future we will test whether the accumulated Snc1 puncta are early form of endosome, by performing a FM4-64 pulse-chase experiment in which early endosomes will be labeled with FM4-64 and the extent of the colocalization between the dye and Snc1-GFP will be analyzed.

#9 – FRACTALINE STIMULATES EXPRESSION OF PROTEINS IN NEURONS AND GLIA IMPLICATED IN THE DEVELOPMENT OF PERIPHERAL AND CENTRAL SENSITIZATION – KEY PROCESSES OF MIGRAINE. Zachary L. Durham and Paul L. Durham, PhD, Biology. Faculty Advisor: Dr. Paul L. Durham.

Fractaline is involved in the development and maintenance of chronic pain states, and thus is likely to play a central role in migraine pathology. I hypothesized that CGRP release from trigeminal neurons would stimulate production and release of fractaline, leading to increased expression of proteins implicated in peripheral and central sensitization. Using immunocytochemistry, CGRP was found to stimulate expression of the fractaline receptor on trigeminal ganglia neurons and glia. Importantly, fractaline, which is released from glial cells in response to CGRP, increased neuronal expression of the P2X3 receptor, which upon activation is involved in pain transmission. Fractaline also increased glial expression of the signaling protein, PKA, which is known to promote the synthesis and release of inflammatory cytokines. Finally, CGRP was shown to stimulate expression of the fractaline receptor in glial cells – both astrocytes and microglia – from the spinal trigeminal nucleus. Upregulation of the fractaline receptor on these cells contributes to the development of central sensitization, a key feature of migraine pathology. Results from our study provide evidence that an inflammatory loop involving CGRP and fractaline is likely to play an important role in the underlying pathology of migraine by promoting the development of peripheral and central sensitization.

#10 – DUAL OREXIN RECEPTOR ANTAGONIST 10 BLOCKS EXPRESSION OF PROTEINS IN NEURONS AND GLIA IMPLICATED IN PERIPHERAL AND CENTRAL SENSITIZATION. Logan Sullivan, Kelly Crowe, Ryan Cady and Paul L. Durham, PhD, Biology. Faculty Advisor: Dr. Paul L. Durham.

Trigeminal nerve activation is implicated in migraine pathology and data from clinical studies support a significant relationship between sleep quality and migraine. Orexins released from the hypothalamus help to regulate sleep patterns in humans and clinical studies have shown promise for orexin antagonists restoring sleep architecture. Furthermore, sleep is often considered an effective and proven treatment for migraine. However, the molecular changes caused by orexin antagonists during chronic inflammation have not been studied. To test our hypothesis, we used a model of chronic inflammation and measured changes in levels of proteins known to be responsible for peripheral and central sensitization in response to administration of Dual Orexin Receptor Antagonist 10 (DORA-10) during inflammation. Rats were injected with complete Freund's adjuvant (CFA) for 2, 5 and 14 days. Some rats received daily administration of DORA-10 after a single injection with CFA. Rats receiving CFA injections had increased expression of p-ERK, p-P38, and Iba1 at 2 and 5 days post injection. However, rats receiving daily DORA-10 had decreased levels of p-ERK, p-P38, and Iba1 compared to rats that received CFA alone. Results from study provide that DORA-10 administration could help to prevent neuronal and glia activation during chronic inflammation.

#11 - CGRP FROM SUPERIOR VENA CAVA SERUM CORRELATES WITH LENGTH OF HOSPITAL STAY AND PHONOPHOBIA DURING THE TREATMENT OF CHRONIC MIGRAINE. Jeremiah Athmer, Carrie Vause, Paul L. Durham PhD, Biology. Faculty Advisor: Dr. Paul L. Durham.

Calcitonin gene-related peptide (CGRP) has been reported to increase in serum and saliva of acute migraine patients. We examined peripheral and jugular serum samples from patients hospitalized with chronic migraine. Serum was obtained from fifteen patients admitted to an inpatient service for the treatment of chronic migraine. Samples were taken three times daily from peripherally inserted central catheter (PICC) lines inserted in the superior vena cava and once daily from the peripheral antecubital

region of the arm. Samples were analyzed for CGRP by radioimmunoassay. Data from serum samples were compared to patient information including headache intensity, length of hospital stay, throbbing pain, photophobia, and phonophobia. CGRP values from PICC and peripheral blood were correlated in chronic migraine serum samples ($p < 0.001$). Peripheral CGRP was not associated with any patient information or symptom. PICC CGRP was negatively associated with duration of hospital stay ($p = 0.008$) and positively with severity of phonophobia ($p = 0.02$). While PICC samples correlated with hospital stay and one migraine symptom, the lack of other supporting correlations suggests a more complex role for CGRP involving factors not considered in this study. More work must be done to further our understanding of the role of this peptide in migraine pain.

#12 – THE GRADUAL DECLINE IN COMMERCIALLY AVAILABLE ANTIBODIES: IMPLICATIONS TO THE RESEARCH COMMUNITY AND A CALL FOR OPEN

COMMUNICATION. Jennifer Rayfield, Jordan Hawkins, and Paul L. Durham, PhD, Biology. Faculty Advisor: Dr. Paul L. Durham.

Two cellular techniques commonly used to study protein expression include immunohistochemistry and western blotting. Both techniques use antibodies to determine protein expression levels and rely entirely on an antibody's specificity to its epitope. While immunohistochemistry uses fluorescent excitation to determine the expression and localization of proteins, western blotting, which utilizes gel electrophoresis to separate proteins based on their molecular weight, is also useful in studying changes in protein expression. Recently, our laboratory has noticed a decline in the quality of commercial antibodies that has compromised our results and necessitated repeating many experiments. In our laboratory specifically, the selectivity and specificity of antibodies that recognize NF- κ B, S100B, and Connexin 43 have not been consistent from lot to lot. To test the quality of these antibodies, we used control and stimulated trigeminal ganglion, brainstem, muscle, and liver tissues to perform immunohistochemistry and western blot analysis on previously and recently purchased antibodies. We found marked differences in antibody selectivity and specificity. We suggest the following possible steps to address this issue: (1) institute more thorough communication between the laboratories and the suppliers and (2) open communication between laboratories nationwide about the quality of reagents via a web-based medium.

#13 - OPTIMIZATION OF TISSUE RETRIEVAL AND PREPARATION FOR IMMUNOHISTOCHEMICAL ANALYSIS.

David Miley, Jordan Hawkins, Filip Garrett, and Paul Durham, Ph.D. Biology. Faculty Advisor: Dr. Paul L. Durham.

Immunohistochemistry is a valuable technique that enables researchers to visualize protein expression in biological tissues. However, different methods of collecting and storing tissue can affect protein expression. Initially, we compared the expression of inflammatory proteins from tissue obtained from animals using two different methods of euthanasia, CO₂ asphyxiation and isoflurane anesthesia, both followed by decapitation. Our results show the expression of key inflammatory proteins in the trigeminal ganglion and upper spinal cord did not differ from either method of euthanasia. Next, we tested different conditions for long-term storage to determine the effect on tissue structure and morphology. All tissues were fixed in 4% paraformaldehyde and cryoprotected in 25% sucrose. Tissues were kept for 2 weeks in 25% sucrose at 4° C or removed from sucrose and placed at -20° C or -80° C. To visualize cell structure and morphology we used antibodies for Neurofilament, a neuronal structural protein, and GFAP, a glial cell filament protein. Our results demonstrate that all conditions are suitable for maintaining tissue integrity. In conclusion, we have verified both methods of euthanasia used in our laboratory are

acceptable for studying inflammatory proteins and that long-term storage of tissue does not affect tissue morphology.

#14 – USING SCLEROCHRONOLOGY TO ANALYZE MUSSEL RECRUITMENT IN THE SAC RIVER, MISSOURI. Daniel A. Brawn, Biology. Faculty Advisor: Dr. Chris Barnhart.

Freshwater mussels are a diverse group of mollusks that live in rivers. Many mussel populations have been reduced by human alteration of rivers, particularly by hydropower dams, which cause rapid swings in water flow downstream and interfere with mussel recruitment (the survival of new individuals in the population). We are studying the recruitment and demography of mussels in the Sac River, which is impounded by Stockton Dam. The age of each mussel is determined by counting external and internal annual growth lines. These growth lines are formed by the slowing of growth during the winter. In some shells the lines are evident externally, but older shells must be sectioned and examined microscopically. Shells are cut with a diamond saw perpendicular to the growth lines. The cut end is then polished and mounted with epoxy on a glass slide. A second cut leaves a thin slice of shell on the slide, which is then ground and polished to a final thickness of approximately 280 μ m. Examination of these sections reveals age as well as patterns of growth. Recruitment of most mussels in the Sac River appears to be prevented in most years by operation of the dam. We have identified two recent events of recruitment in the Sac River, when many mussel species successfully reproduced. One of these events was in 2005-06, when a severe drought prevented hydropower generation at Stockton. Another occurred in 2009, when generation was interrupted for one year by a mechanical failure.

#15 - SYNTHESIS AND CHARACTERIZATION OF TWO SUBSTITUTED ACETONITRILES – PRECURSOR FOR CYANOXIMES THAT FORM LIGHT INSENSITIVE AG(I) COMPLEXES. Courtney Riddles and Dr. Nikolay Gerasimchuk, Chemistry. Faculty Advisor: Dr. Nikolay Gerasimchuk.

The reaction between neat secondary amines – N-piperidine and morpholine – with cyanoacetic esters in the absence of any solvents leads to substituted acetonitriles NC-CH₂-C(O)-N(CH₂)₄X in high yield (X = CH₂ for piperidine, X = O for morpholine). Both compounds represent colorless or off-white microcrystalline solids that were characterized by ¹H, ¹³C NMR spectroscopy, IR-spectroscopy and X-ray analysis. Both compounds crystallize in orthorhombic system and the geometry of the amid groups evidenced partial double bond character in the C(O)-N fragment and explains the absence of rotation around C-N bond detected in their NMR spectra. Synthesized substituted acetonitriles were successfully converted into respective cyanoximes, HPiPCO and HMCO, using gaseous methyl nitrite CH₃-ONO at ambient conditions. Deprotonation of these cyanoximes with KOH in aqueous solutions with subsequent addition of AgNO₃ affords thick, yellow precipitates of AgL (L = PiPCO-, and MCO- anions), which were characterized via elemental analyses and IR spectroscopy. Both Ag(I) complexes are planned for studies of resistance towards an intense visible light (400 nm) and UV-light (256 nm) with intent to use them as light-stable antimicrobial additives to light-curable acrylate-based adhesives and composites used during introduction of indwelling medical devices and dental implants.

#16 – SYNTHESIS, SPECTROSCOPIC AND STRUCTURAL CHARACTERIZATION OF NEW POTENT CARBONIC REDUCTASE INHIBITOR – 2,4-DICHLOROPHENYL-CYANOXIME.. Michael Hilton, Arkadii Ellern and Nikolay Gerasimchuk, Chemistry. Faculty Advisor: Dr. Nikolay Gerasimchuk.

The reaction between a solution of 2,4-dichlorophenyl-acetonitrile and gaseous methylnitrite CH_3ONO in n-propanol leads to the target cyanoxime $\text{H}(2,4\text{-diCl-PhCO})$ with a 85% yield. The compound represents a colorless microcrystalline solid that was characterized by ^1H , ^{13}C NMR spectroscopy, IR-spectroscopy and UV-visible spectroscopy. Both the starting substituted acetonitrile and the final cyanoxime were studied using the X-ray single crystal analysis. The crystal structure of the starting compound evidenced two positional disorders in the chlorinated aromatic residue. The deprotonation of the $\text{H}(2,4\text{-diCl-PhCO})$ with KOH in aqueous solution leads to yellow anion in its K-salt. This cyanoxime was prepared in multi-gram quantities for its further biological investigations that will include determination of the ID_{50} index and mammalian toxicity for the future in vivo studies.

#17 - SUBSTRATE SPECIFICITY OF SEVERAL ISOFORMS OF 2,4-DIENOYL-COA REDUCTASE IN RAT LIVER. Thomas Marcink, Steve Kramer, Tim Hubbard, Chemistry. Faculty Advisor: Dr. Dean Cuebas.

Fatty acids are a major energy source and are degraded via a β -oxidative process in both mitochondria and peroxisomes. Unsaturated fatty acids with double bonds extending from even-numbered carbons require in addition to the four β -oxidation enzyme necessary for saturated fatty acid degradation, two auxiliary enzymes, 2,4-dienoyl-CoA reductase and 3,2-enoyl-CoA isomerase. The reductase (DECR) catalyzes the hydrogenation of 2,4-dienoyl-CoAs to 3-enoyl-CoAs and utilizes exclusively NADPH as the reductant. In animals, DECR has been found associated with both mitochondria (DECR1) and peroxisomes (DECR2). These two isoforms display high sequence homology and the crystal structure of the mitochondrial isoform is known. Using hydroxyapatite chromatography, our group has clearly demonstrated the existence of at least one additional isoform of 2,4-dienoyl-CoA reductase in rat liver. A phosphate gradient allows for the separation of early eluting (DECR2), middle (new isoform), and later eluting (DECR1) isoforms. Various 2,4-dienoic acids and their Coenzyme A derivatives were synthesized and used to probe the substrate specificities of the three isoforms of 2,4-dienoyl-CoA reductase. The uncharacterized isoform displays a substrate specificity that is very different from either DECR1 or DECR2 and supports the conclusion that this activity represents a new enzyme whose purpose remains to be discovered.

#18 - REAL-TIME SNOW ACCUMULATION. Henry G. Stratmann III, Computer Science. Faculty Advisor: Dr. Eric Shade.

Do you remember the first time you saw Pirates of the Caribbean II? Remember when Davy Jones first appeared on screen and how realistic his tentacle-like beard appeared? What about when the Black Pearl and its crew faced off against the Kraken—remember how realistic that scene looked? Now think about how the effects in movies compare to the effects in video games. For the most part, the animation in video games doesn't look nearly as good as what you see in the movies. Why is that? Well, the reason is simple: movies are pre-rendered whereas games are rendered in real-time. The scene on the Black Pearl when the Kraken attacks most likely took hours to render! However, it would make gamers very angry if they had to sit and wait 3 hours to watch Pacman eating a power pellet. Thus, a compromise must be struck between what looks good and what's fast. What I am proposing is a way to render snow accumulation on an arbitrary set of geometry that not only looks good, but runs in real-time. This effect, up until now, has been difficult to reproduce in real-time because snow has so many variables: wind,

stickiness, temperature, size of flakes, etc. However, I have developed a method of rendering it efficiently. With this technique, we move another step closer to bridging the gap between pre-rendered and real-time rendering.

#19 - EXPLORING THE VERSATILITY AND DURABILITY OF CONCRETE IN THE APPLICATION OF BUILDING A CONCRETE CANOE. Matt Weber, Jared Davis and Andrew Coleman, Engineering. Faculty Advisor: Dr. Matthew Pearson.

Many civil engineering programs have a long history of competition in the annual ASCE concrete canoe competition. There are many hurdles to clear when a new school without previous experience, such as the Cooperative Engineering Program at Missouri State University, embarks on successful completion of a competitive concrete canoe team. One challenge is that the density of the concrete used must be about approximately one third that of traditional concrete. This requires the use of specialized recycled aggregates, which increases the difficulty of the mixing process and can reduce strength significantly. The construction process is not a trivial challenge either, and special measures must be taken to assure the final product is light, strong, and aesthetically pleasing. This presentation will discuss how the MSU students developed the first concrete canoe team in school history.

#20 - CREATING AN EDUCATIONAL SPELEOLOGICAL PACKET FOR GREENE COUNTY MISSOURI PARKS BOARD. Brandy M. Henderson and Anastasia Doennig, Geology. Faculty Advisor: Dr. Douglas Gouzie.

Greene County, Missouri has numerous caves that are on public property. The Greene County Parks Board considers them a valuable natural resource. The caves are utilized by the Outdoor Initiatives Program to educate the community. In an effort to better educate the public, the Outdoor Initiatives Director asked members of the Missouri State University's Speleology class to create an informative packet. The packet was created for a wide-ranging target audience ranging from elementary school students and their teachers to the general citizen with no previous knowledge of caves. The packet includes photos and information on cave history, geology, formations, biota, karst, groundwater, management, and safety. A separate packet was also created for a 60-acre natural resource area that the park board was soon opening to the public. The natural resource area includes numerous caves and karst features, which required site visits and field notes taken as part of the process. The natural resource area packet includes previously created cave maps as well as the information on the formation and features of each of the caves in the area. This presentation will describe the process of preparing these educational materials and will include sample pages from the project.

#21 - SUSPENDED AND DISSOLVED CARBON IN STORM-WATER RUNOFF IN THE JAMES RIVER BASIN. Stephanie Prevedel and Terry Phillips, Geography. Faculty Advisor: Dr. Bob Pavlowsky and Heather Hoggard, Ozarks Environmental and Water Resources Institute.

Carbon transport in streams plays an important role in controlling carbon storage and water quality in watersheds. This study compares the suspended and dissolved carbon concentrations among streams with different urban area percentages and drainage areas. Bulk water samples were collected from storm-runoff during first flush periods in tributaries and main stem locations in the upper and middle James

River Basin in Greene and Christian Counties in southwest Missouri during February and March of 2011. A TIC-TOC Analyzer was used to measure total organic carbon (TOC), total inorganic carbon (TIC), and non-purgeable organic carbon (NPOC) content in water and suspended sediment. It is expected that higher OC concentrations will be found in storm-water from forested areas, disturbed or eroding soils, or larger rivers with higher suspended sediment loads overall. The results of this study will be compared to those from a previous study of carbon concentrations in larger rivers in the basin

#22 - SPATIAL ANALYSIS OF PARKING LOTS TO EVALUATE PAH CONTAMINATION AND SOURCES, GALLOWAY BRANCH WATERSHED, SPRINGFIELD, MISSOURI. Daniel Williams, Geography. Faculty Advisor: Dr. Robert Pavlowsky, Ozarks Environmental and Water Resources Institute.

Erosion and solution of coal-tar sealant coatings on parking lots are a contamination source of polycyclic aromatic hydrocarbons (PAHs) to urban streams. The City of Springfield is concerned about the negative effects that PAHs may have on human health and aquatic life. This study reports on the first step in a broader study to complete a city-wide evaluation of PAH concentrations in stream sediments and their sources. Sediment samples will be collected from stream channels, storm water basins, ponds, and parking lots and then analyzed for the presence of PAHs. To begin to understand the spatial distribution of potential sources of PAHs in the city, I have used 6-inch resolution aerial photography to assess all commercial parking lots within the Galloway Branch watershed drains southeast Springfield. Parking lots were then manually digitized using the GIS program ArcMap. Lots were classified into those with coal tar coatings and those with uncoated asphalt and cement. Lot distribution is quantified and attributed according to surface area, proximity to streams, and local land use. The results of this study will be used to determine the locations of sediment sampling sites and to estimate source loadings of PAHs to the stream system.

#23 - TEMPERTAURE TRENDS AND UTILITY USE IN SPINGFIELD, MISSOURI: A CLIMATE CHANGE ASSESMENT TOOL. Caroline Pavlowsky, Geography. Faculty Advisor: Dr. Judy Meyer.

Climate change can have consequences on the use of energy in urban areas. This study evaluates the relationship between monthly temperature trends and energy/water use in the Springfield, Missouri metropolitan area. A five year record of temperature is correlated with natural gas, electric, and water use. Second order polynomial regression equations are used to develop temperature-energy/water use models (TEMs). Electric use peaks in both summer and winter, while gas use is highest in winter and lowest in summer. Mean annual Midwest temperatures are projected to increase by 2 degrees Celsius over the next 30 years. The effect of different warming scenarios on energy use and typical home utilities cost is evaluated using the TEMs. Warming scenarios based on mean energy use trends predict no increase in utility cost to the typical homeowner since reduced gas heating use offsets the additional costs for electric cooling. However, modeling scenarios using peak energy use indicate an increase in utility costs. Relationships among climate trend, energy use, and cost are complex and dependent on the distribution of warming over the seasons, energy supply/cost to the community, and land use/behavior factors.

#24 - LEAD CONTAMINATION AND FLUVIAL DISPERSAL OF CHAT GRAINS IN THE BIG

RIVER FROM THE OLD LEAD BELT, SOUTHEAST MISSOURI. Susan Helwig, Geology.

Faculty Advisor: Dr. Robert Pavlowsky, Ozarks Environmental and Water Resources Institute

Lead (Pb) contamination in channel sediments can be found along 90 miles of the Big River in Southeast Missouri. This contamination problem was caused by the release of mining wastes to the river from the Old Lead Belt Mining District from 1869 to 1972. Most of the contamination comes from crushed sand- and gravel-sized tailings that were stored and released from dump sites in St. Francois County. The major rock unit that is contributing the Pb ore contamination is the Bonne Terre Dolomite. The purpose of this study was to determine the contribution of mining chat to present-day bed and bar sediments in the Big River. We hoped to better understand the distances of downstream transport of chat and degree of coarse-grained contamination in the Big River. Chat grains from river sediment samples were examined at various sites in the mining areas and in upstream control sites along the Big River. The grain sizes evaluated were in the fine-gravel range which dominates chat material composition. The Bonne Terre dolomite was separated out and counted along with the natural chert and quartz. Concentrations of the 8-16 mm dolomite chat grains are higher closer to the mills, and 4-8 mm dolomite chat grains concentrate farther down the river. This pattern is most likely due to the natural weathering of the carbonate rock and the ability of rivers to selectively transport smaller particles farther downstream. Detailed analysis of the mineralogy and geochemistry of contaminated bed sediments will be presented.

#25 - Preliminary Results of Radon in Geologic Materials in the Springfield and SW Missouri

Areas. Ken L. Wright, Charles D. Shepherd, Laura Thayer, Ashley C. Dameron, Jeremy D. Purcell, Geology. Faculty Advisor: Dr. Erwin Mantei.

A study of Radon-222 in soil and bedrock samples in Southwest Missouri was conducted. A sample of fertilizer was also included. Relative radon content was determined using values of radon's decay parent, Radium-226, since no standards were available. All collected sample locations were mapped using a Garmin GPS- map-76 unit. All samples were treated and analyzed under the same physical conditions. Each was dried, disaggregated or crushed in a porcelain mortar and pestle, sieved, and 600 grams of the <63 mesh portion of each sample transferred to a Marineli Beaker. Each sample was counted for 20 hours in a 4020 Canberra Gamma Spectrum Analyzer and the Radium content was recorded. Results indicated certain shale bedrock samples contained much higher Radon content. Also, Radon content increases with soil depth. In addition, use of fertilizers may cause higher Radon content in soils. Hence, buildings and homes whose foundations are constructed in the aforementioned soils and bedrock may contain dangerous concentrations of Radon. More local and Kansas City area soil and associated bedrock samples need to be studied. Radon concentrations in buildings and houses constructed in these soils, and different fertilizers placed on these soils need to be researched further.

#26 - LITHOLOGICAL ANALYSIS OF THE DESCARTES REGION USING MOOD

MINERALOGY MAPPER DATA. Alicia A. Metzger, Geology. Faculty Advisor: Dr. Kevin Mickus

The introduction of CCD cameras to orbital satellites has significantly increased our ability to analyze the composition of naturally occurring planetary materials. This method is employed by observing the characteristic of light not only in the visible range (390-750 nm), but across the electromagnetic spectrum (405-3000 nm). The Moon Mineralogy Mapper (M³), a NASA

supported guest instrument on India's Chandrayaan-1, is a state-of-the-art imaging spectrometer that was launched in 2008. Since that time, a number of data products have been released and each level has been subjected to a number of calibration techniques. This is necessary to compare hyperspectral image spectra with reference reflectance spectra. We have been able to classify these materials remotely without the usual physical contact that is required to identify them by utilizing the nature of light's interaction with rocks and minerals. Remote sensing analysis programs, such as ENVI, have the ability to calibrate imagery to increase the efficiency of interpretation. For recently released level L1B data, this research focuses on comparing two methods of calibration, Flat Field and IAR Reflectance corrections. The results of the spectral analysis will then be used to create a supervised classified image that will show the distribution of rock types of the region in the study area. The results provide a basic understanding of the composition of lunar material in the Descartes region, and suggest that further calibration methods should be implemented to increase the efficiency of spectral analysis. This information contributes to our knowledge of the geologic evolution of crustal material, in addition to supporting in-situ resource utilization for future manned missions to the moon.

#27 – ANALYSIS OF QUARTZ BASALT DIKES. Sam Hooker, GGP. Faculty Advisor: Dr. Thomas Plymate.

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#28 - METRICS ON THE PLANE AND DISTANCE FOR TAXICABS IN RADIAL CITIES. Ali Soliman, Mathematics. Faculty Advisor: Dr. Les Reid.

A metric is a generalization of the notion of distance in the plane, which may apply to more general sets than the plane. However the usual distance formula is not the only metric that one may define on the plane. The most well-know example of such alternative ways to measure distance between two points is the taxicab metric, defined by the sum of the absolute values of the differences in each coordinate. This is analogues to the shortest path a taxi could take in an ordinary grid city, hence the name. However, not all cities are grid, some have an approximately radial design, that is, the streets are either lines through the city center or are concentric circles centered there. We consider travel in which moves along only radial lines and arcs, and show that one may define a metric by the minimum distance when moving along radial lines and a single circular arc. We then elucidate some basic properties of the plane under this new metric.

#29 - GEOMETRIC TECHNIQUES FOR SOLVING A CERTAIN DIOPHANTINE EQUATION. Nathan Hall, Mathematics. Faculty Advisor: Dr. Les Reid.

Given an equilateral triangle with sides of length d and a point whose distances from the three vertices of the triangle are a , b , and c , then

$$a^4 + b^4 + c^4 + d^4 = a^2b^2 + a^2c^2 + a^2d^2 + b^2c^2 + b^2d^2 + c^2d^2.$$

We use geometric techniques to find non-trivial integer solutions to this equation.

#30 - PREPARING AND CALIBRATING AN ULTRA-HIGH VACUUM SYSTEM FOR GROWTH OF ARGON AND METHANE ICES. Cory J. Honer, Steven K. Armour, Physics. Faculty Advisor: Dr. Dave Cornelison.

The presence of frozen volatiles in Kuiper Belt Objects (KBOs) has been realized for decades, but their relative stoichiometry is still a topic of debate. The dwarf planets Pluto and Eris are both KBOs and are of particular interest when attempting to determine volatile abundances. In 2007, Schaller and Brown determined that both dwarf planets were sufficiently massive enough and cold enough to retain volatiles on their surfaces older than the age of the Solar System. The goal of our research is to match spectra of the icy surfaces of Pluto and Eris with ices grown in the lab. Success in accomplishing this will help us to better understand the stoichiometry of the frozen volatiles on their surfaces. Having recently finished our ultra-high vacuum lab setup, we are now beginning the task of growing our first ices and calibrating our system. Upon completion of calibrating our system, we will begin studying the spectra of methane and Argon ices of various stoichiometries for comparison with spectra of Pluto and Eris.

#31 – TRANSPARENT SPINTRONICS USING PULSED LASER DEPOSITION TECHNIQUE. G. Aboagge-Asare, K. Ghosh, Y. Kolekar, and P.K. Kahol, Materials Science. Faculty Advisor: Ram Gupta

Spintronic materials have attracted considerable attention due to their potential applications in electronic devices. Spintronics are fabricated by doping small amount of magnetic impurities in metal oxides such as ZnO, TiO₂, SnO₂, and In₂O₃. Among them In₂O₃ is very popular because of its high transparency and electrical conductivity. We have deposited high quality Cr-doped In₂O₃ diluted magnetic semiconductor thin films using pulsed laser deposition technique. The effect of growth parameters on structural, optical, and electro-magnetic properties of these films is studied. X-ray diffraction studies show that Cr-doped In₂O₃ have preferred orientation along (222) direction. We don't see any additional peaks due to Cr-doping, indicating single phase In₂O₃. The optical bandgap of the films were calculated using transmittance data. It is observed that structural, optical, and electrical properties strongly depend on growth conditions. The temperature dependence electrical resistivity measurements show transition from semiconducting to metallic behavior.

#32 - USING CCD DIFFERENTIAL PHOTOMETRY TO DETECT VARIABILITY IN YELLOW SUPERGIANTS. Laurel Farris, Physics. Faculty Advisor: Dr. Robert Patterson.

This project involved the observation of yellow supergiant stars and searching for variability (or confirming the lack thereof). This particular project was carried out from early June to December of 2010. Nine stars were studied during the summer and ten more were chosen for study through the fall and early winter. Regular observing sessions were attended at Baker Observatory, (about one or two nights a week) where several images were taken of each star for each night. Later these images were calibrated and aperture photometry was applied to obtain the average change in magnitude of each star over time. Light curves were constructed for each star over the duration during which that particular star was observed. We looked for periodicity using the "pdm" application in IRAF and the AVE program in windows. All data were compared and contrasted to the Hipparcos (HIP) catalogue (though not all stars had HIP data available) to check for consistency. Most stars did not show any significant variability, so we can confirm that they are pretty constant. There were a few that did appear to be slightly variable, and one confirmed variable that showed almost 2 magnitudes difference.

#33 - TRANSITION METAL DOPED OXIDE DILUTE MAGNETIC SEMICONDUCTORS FOR SPINTRONIC APPLICATIONS. Michelle Langhoff, Dr. Y. D. Kolekar, and Dr. Ram Gupta, Materials Science. Faculty Advisor: Dr. Kartik Ghosh.

The electronics industry owes its success to the special properties of semiconductors. However, the next generation of technology hopes to incorporate new materials called dilute magnetic semiconductors (DMS), resulting in a new type of technology termed spintronics. Spintronics presents numerous advantages over electronics including greater reliability, faster response time, and lower energy consumption. DMS materials, upon which spintronics rely, comprise a new class of ferromagnets formed by incorporating small amounts of transition metals such as iron or cobalt into standard semiconductors such as TiO_2 , ZnO , or In_2O_3 . In particular, transition metal doped In_2O_3 creates a unique system through which controlling the defect concentration allows for tuning the electrical and magnetic behavior from ferromagnetic metal-like to ferromagnetic semiconducting to paramagnetic insulating. Cobalt doped In_2O_3 has been made using a standard solid state reaction method at the 2%, 4%, and 6% levels. Structural and magnetic properties have been carried out using x-ray diffraction and superconducting quantum design magnetometer, respectively.

#34 - RECENT DISCOVERIES FROM NASA'S KEPLER SATELLITE. Amanda Quint, Astronomy. Faculty Advisor: Dr. Mike Reed.

The primary mission of NASA's Kepler satellite is to detect planetary candidates. During its first year it has found over 1200 candidates. It is also staring at over 150,000 stars without blinking. My work is to use this data to peer inside of late-evolution stars. First year discoveries include: testing special relativity using close binary stars; detecting surface granulation for the first time on a star other than our Sun; measuring tidal distortions as two stars go zooming past each other; and measuring the internal properties of red giants, solar-like stars, and blue subdwarfs.

#35 - SPINTRONIC APPLICATIONS USING CHROMIUM DOPED INDIUM OXIDE. Edward Nahlik, Dr. Ram Gupta, Dr. Pawan Kahol, and Dr. Yesappa Kolekar, Materials Science. Faculty Advisor: Dr. Kartik Ghosh.

Tremendous research efforts are underway to exploit the property of electron spin in spintronics. Spintronic devices critically depend on the availability of a specific materials system for spin injection, manipulation and detection. Transition metal (Cr, or Co) doped wide band gap oxide semiconductors possess these properties. Indium oxide (In_2O_3) is a wide band gap semiconductor with unique optical and electrical properties. Here, we investigate the effect of Cr doping on structural and magnetic properties of indium oxide. Cr ion is doped in In_2O_3 using solid state reaction method. Structural and magnetic properties have been measured using standard techniques. X-ray diffraction analysis confirmed single phase Indium oxide with no impurity phases due to addition of Cr. Magnetization as a function of applied magnetic field and temperature were collected on all the samples using a superconducting quantum interference device magnetometer. Detailed magnetic properties will be discussed in this presentation. This

work is supported by National Science Foundation (Award Number DMR-0907037)

#36 – Differential CCD Photometry of Yellow Supergiant Stars in Fall 2010. Jennifer Bean, Astronomy. Faculty Advisor: Dr. Robert Patterson.

This is a part of an ongoing research project by Dr. Patterson to identify low-amplitude variation in Yellow Supergiant (YSG) stars. We picked F and G stars from SIMBAD to observe at Baker Observatory. The stars were observed from August to November and were evaluated using IRAF. The stars included possible YSG stars and a known YSG star as a check star. The variability of the stars were checked and then the periods were calculated. The programs used to calculate the period were the phase dispersion minimization (PDM) program in IRAF and Analisis de Variabilidad Estelar (AVE).