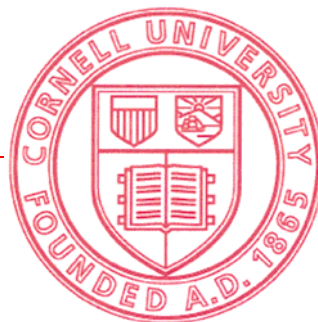


# College of Agriculture and Life Sciences

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**2013—2014**

## **Research Honors Program Abstracts**





The College of Agriculture and Life Sciences (CAL S) is considered among the finest of its kind in the nation, if not the world. As the land-grant college of agriculture and life science of New York State, our mission is to discover, integrate, disseminate, and apply knowledge with a public purpose in the life sciences, environmental sciences, food and energy systems, and economic and community vitality, as a basis for sustainable improvement in the lives of people throughout New York, across the country, and around the world.

Nothing is more critical to the success of the college's mission than an engaged and inspired student body, as exemplified by the students who earn a bachelor's degree with honors. The 2013-2014 honors thesis projects described in this booklet demonstrate an impressive capacity for personal dedication, mature scholarship and intellectual growth. The original research contained herein examines some of the most pressing and relevant questions of our time.

Many students consider the research projects they undertake as undergraduates in CAL S to be among the most challenging, enduring, and rewarding experiences of their time at Cornell. As a faculty member, I have witnessed first-hand among my own advisees the formative impact that undergraduate research can have on budding young scientists. As dean, I am dedicated to fostering the college's unwavering commitment to providing our undergraduates with these life-changing research opportunities.

I am extremely proud of our undergraduate students and their achievements, and I wish them the very best in their future endeavors. I am also proud of the dedicated faculty who supervised these honors research projects and mentored these students to their fullest potential. As you will see from reading the following abstracts, these new graduates will soon take their place among tomorrow's scientific leaders and innovators.

Kathryn J. Boor, Ph.D.  
*The Ronald P. Lynch Dean of  
Agriculture and Life Sciences*

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## The Effects of Microalgae Supplementation on Non-Alcoholic Fatty Liver Disease

JAIMEE R. ALSING

Under the supervision of Dr. Xingen Lei  
Department of Animal Science

Studies have shown that blue-green algae supplementation is able to reduce non-alcoholic fatty liver disease (NAFLD). With the increased production of biofuel from microalgae, it would be beneficial to use this algae as a supplement instead. This study was conducted in a mouse model to examine if microalgae are also capable of reducing NAFLD. Zn, Cn, superoxide dismutase (SOD1) knockout mice and wild type mice were fed a treatment diet of 5% microalgae or a control diet for four weeks. On week 0, 1, 2 and 4 plasma was tested for cholesterol, non-esterified fatty acids and triglyceride content. Postmortem livers were weighed and compared to body weight in order to determine occurrence of NAFLD. Triglyceride and non-esterified fatty acid levels remained the same for the duration of the trial, but cholesterol levels were significantly reduced by the microalgae supplementation in the knockout mice ( $p < .05$ ). Liver to body weight ratios and liver triglyceride content was significantly reduced by the microalgae supplementation in knockout mice ( $p < .01$ ). Finally, hepatic cholesterol content was significantly reduced ( $p < .05$ ). In conclusion, the addition of microalgae to the diet shows reduction in NAFLD.

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## Effects of Photoperiod on Novelty Preference in Preadolescent Siberian Hamster (*Phodopus sungorus*) Pups

COLLEEN A. BARRETT

Under the supervision of Dr. Ned J. Place  
Department of Population Medicine and Diagnostic Sciences

Photoperiod (day length) has been shown to have significant effects on the physical and behavioral development of seasonally breeding mammals and to modulate the timing of their dispersal from the natal burrow or den. Behaviors associated with dispersal, such as novelty preference and exploratory behaviors, have been shown to be modulated by anti-Müllerian hormone (AMH) in mice. Whereas photoperiodic modulation of serum AMH concentrations in female Siberian hamsters (*Phodopus sungorus*) has been demonstrated, novelty preference and exploratory behaviors have not been previously investigated in this species. Through the manipulation of day length (DL) in Siberian hamsters, this study sought to determine if photoperiod-induced differences in serum AMH concentration correlate with behaviors that are associated with dispersal. Although AMH was significantly different in males and females, and day length had a significant effect on AMH in males, our evaluations of novelty preference and exploratory behaviors revealed no effects of sex or photoperiod when evaluated at 21 days of age. The information acquired from this study will contribute to the understanding and characterization of the associations among DL, AMH, and the behaviors associated with the dispersal of adolescent mammals. Utilizing this study's results, future research is required to determine the age at which sex differences in novelty preference and

exploratory behavior are first apparent in Siberian hamsters and to evaluate variations in AMH associated with age, sex, and photoperiod.

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## The Effects of 4-aminopyridine and Heparin in the Motility of Bovine Sperm

ZARAH DEUTSCH

Under the supervision of Dr. Susan Suarez  
Department of Biomedical Sciences

As bovine sperm enter the female oviduct, the oviductal storage reservoir is formed. During transport up the female tract, sperm progressively bind and detach many times in their effort to reach and fertilize the egg. Sperm must undergo the transformative process of capacitation in order to detach successfully from the oviductal lining. In vitro, both 4-aminopyridine (4-AP) and heparin have been found to be necessary in order to facilitate detachment. In this study we looked at the effects of both 4-AP and heparin on fresh and frozen thawed free-swimming sperm. We hypothesized that both 4-AP and heparin would produce an increase in hyperactivation rates in fresh and frozen thawed sperm. In order to test this hypothesis, we exposed both fresh and frozen thawed sperm to varying levels of 4-AP with and without heparin and analyzed the percentages of sperm exhibiting hyperactivated motility. The addition of heparin was not found to increase the rates of hyperactivation in either fresh or frozen thawed sperm, unlike 4-AP (a commonly used hyperactivating agent). Heparin must necessarily contribute to increased detachment from the oviduct via other mechanisms that are not motility-related.

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## Laterality of the Raised Leg Urinary Posture in Domestic Dogs (*Canis lupus familiaris*)

WILLIAM T. GOUGH

Under the supervision of Dr. Betty A. McGuire  
Department of Ecology and Evolutionary Biology

Motor laterality is the preference an animal shows for using one limb or lateral half of its body over the other. In domestic dogs (*Canis lupus familiaris*), laterality studies have focused on front paw preferences during staged, artificial tasks. Our study examined whether laterality is shown during the raised leg urinary posture typically displayed by mature male dogs and the squat-raise posture displayed by some mature female dogs. We directly observed individual dogs during walks at two animal shelters and recorded the posture used for each urination and the leg raised, if any. First, we examined whether raising a leg during urination varied with sex, age, reproductive status (intact versus neutered/spayed), body size, shelter, or time spent at the shelter. Second, for those dogs that raised a leg during urination, we examined strength of laterality and whether a population bias existed with respect to leg raised. Consistent with previous findings, we found that propensity to raise a leg during urination was higher in males than females and higher in adults and seniors than in juveniles. We found only moderate laterality strength in most dogs; a relatively small proportion of

dogs showed strong lateralization. We found no evidence of a population bias with respect to leg raised. Our study confirmed for shelter dogs the effects of sex and age previously reported for dogs living under other conditions. Contrary to what has been reported for front paw behaviors, we found few lateralized dogs with respect to the hind leg raised when urinating.

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## Expression of Adiponectin during the Pregnancy-Lactation Cycle in the Sheep

KATTI HORNG

Under the supervision of Dr. Yves Boisclair  
Department of Animal Science

Ruminants such as dairy cows and sheep suffer from reduced feed intake and negative energy balance during the transition from late pregnancy to early lactation. These animals are good models for metabolic adaptations during pregnancy and lactation due to their genetic capacity for growth and milk production. During this transition period, ruminants develop insulin resistance leading to increased mobilization of lipids from adipose tissue and decreased glucose utilization in muscle. Adiponectin, also known as Acrp30 or Adipoq, is a protein hormone secreted by adipocytes. Adiponectin circulates in oligomers composed of 3, 6 or 16-24 monomers and known respectively as low molecular weight (LMW), medium molecular weight (MMW), and high molecular weight (HMW) form. In other species, adiponectin has been shown to regulate insulin action. Transgenic mice overexpressing adiponectin display improved insulin sensitivity while adiponectin knockout mice exhibit diet-induced insulin resistance. These results suggest that adiponectin is an insulin-sensitizing hormone. Recent work in dairy cows showed that a reduction in plasma adiponectin occurs around parturition and that adiponectin circulates exclusively in HMW form. The goal of this research is to (1) determine whether or not plasma adiponectin around parturition changes in the sheep as it does in the cow, (2) examine the molecular weight distribution of adiponectin in periparturient sheep, and (3) determine whether adiponectin variables in sheep are correlated with changes in plasma variables indicative of insulin action (glucose, NEFA, insulin, leptin).

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## The Effect of Inhaled Carbon Dioxide on Laryngeal Abduction in Canines

AMANDA JONES

Under the supervision of Dr. Jon Cheetham  
Department of Clinical Sciences

Laryngeal paralysis is the most common laryngeal disease affecting humans and canines, with the canine larynx serving as a widely accepted clinical model of human disease. Current diagnosis of laryngeal paralysis in canines includes subjective and insensitive techniques that evaluate arytenoid movement during resting physiological states. To improve laryngeal assessment, we tested the effects of increasing inhaled carbon dioxide levels to stimulate laryngeal function. Canines were exposed to a carbon dioxide gradient to first determine the optimal carbon dioxide concentration necessary to obtain optimal increase of glottal area. Blood gas analysis was used to determine any

acidotic effects. Later, canines were exposed to three 60-second bursts of mild hypercapnia (end tidal carbon dioxide of 90mmHg) with 15 minutes of washout between periods. Measurements of the rima glottis cross sectional area demonstrated the consistent, rapid increase of glottal area that corresponded to the predetermined carbon dioxide concentration (90mmHg). Peak laryngeal response was reached within 10 seconds of the end of the carbon dioxide burst, and peak glottal area was highly repeatable across each burst. The repeatable response of laryngeal function to a quantified carbon dioxide concentration allows for improved evaluation of arytenoid movement while maintaining a safe physiological state. By maximizing respiratory drive and laryngeal response, this method contributes improvements for evaluating canine laryngeal function during endoscopy.

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## Molecular Genetic Studies of the Bovine GALNT13 Gene

JOEY N. LAMASTRO

Under the supervision of Dr. Ikhide Imumorin  
Department of Animal Science

Fertility is a low heritability trait in livestock that is very difficult to improve using traditional selection. Therefore, researchers have turned to improving this trait through genomics approaches, which allows for gene-assisted or genomic selection. Previous genome-wide association (GWAS) studies in Brangus cattle identified a quantitative trait locus (QTL) region on bovine chromosome 2, and following RNA sequencing (RNA-Seq) profiling of the hypothalamus identified several genes within a 4-Mb window (among them a gene called GALNT13) as possible candidates for early heifer pregnancy. With very little information on bovine GALNT13, the goal of this project was to conduct molecular genetics studies of bovine GALNT13 using both experimental and computational methods. Molecular genetic analysis covered tissue expression, single nucleotide polymorphism (SNP) identification and phylogenetic analysis of bovine GALNT13. Tissue expression analysis using reverse transcriptase polymerase chain reaction (RT-PCR) of exon 2 showed that bovine GALNT13 is expressed in brain, spinal cord, liver, and kidney. Sequences of PCR amplicons of genomic DNA from 13 animals were compared to identify 11 SNPs indicating significant genetic diversity within this gene. Phylogenetic trees constructed from multiple mammalian mRNA sequences supports strong evolutionary conservation across many species.

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## Evaluation of Feed Efficiency, Residual Feed Intake and Nutrient Partitioning in High Producing Lactating Dairy Cattle

PAUL ANDREW LAPIERRE

Under the supervision of Dr. Mike Van Amburgh  
Department of Animal Science

Feed efficiency is one of the ways a producer can assess the productivity of a cow. Feed efficiency is influenced by many factors, including the partitioning of nutrients and Residual Feed Intake which

measures the difference between actual and the predicted feed intake of a cow as a source of efficiency. 64 Holstein cows varying in lactation number, days in milk, and body weight were evaluated for factors relating to feed efficiency over 120 days. Feed offered, feed refusals, body weight and body condition scores, and milk yield were recorded and/or sampled on a daily or weekly basis. Fecal spot sampling was conducted three times throughout the study. Fecal samples were taken every 6 hr on 8 occasions, encompassing a 48 hr window. Feed offered, feed refusals, and fecal samples were analyzed for neutral detergent fiber (NDF) content, undigestible neutral detergent fiber (uNDF) content, energy, protein, fat, and dry matter content. Milk samples were analyzed for lactose, true protein, and fat content to calculate energy content of the milk. Feed efficiency of the cattle was studied by evaluating how the cows partitioned their nutrients and their calculated residual feed intake. The proportion of total energy used for milk yield was used to determine nutrient partitioning within the group. Observed dry matter intake was compared to a model predicted dry matter intake to calculate residual feed intake. After standardizing the results it was concluded that within this data set, nutrient partitioning and residual feed intake equally influenced feed efficiency.

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## The Role of Animal Welfare Legislation in Shaping Child Protection in the United States

ELIZABETH W. LEBOW

Under the supervision of Dr. Debbie J. Cherney  
Department of Animal Science

The aim of this thesis is to study the role that the development of animal welfare legislation had on shaping child protection in the United States. Although it is well known that the same individuals responsible for animal protection were involved in the subsequent creation of child welfare legislation, most historical discussions of child welfare begin only at the intervention of those individuals. I sought to combine the topics, and examine how closely the foundation of animal protection related to child protection in the United States. In order to study the ways in which the animal protective movement influenced child protection in the United States, I conducted a review of the relevant literature including books and journal articles on the topics, court cases and documents, and state and federal statutes. Through my research, I found that the framework for the creation and enforcement of child protective laws was modeled almost entirely after animal protection. Thus, I concluded that child protection in the United States would not be the same if it were not for the preceding animal protection movement. Although the two movements share roots, with time animal and child protection have diverged as a result of the notion of social work for families.

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## Interrelationships among Calcium Parameters and Neutrophil Oxidative Burst Activity in Early Postpartum Dairy Cows

ELIZABETH M. MARTENS

Under the supervision of Dr. Thomas R. Overton  
Department of Animal Science

Understanding the role of calcium and diagnosis of subclinical hypocalcemia (SCH) in postpartum cows is of interest to the dairy industry and could impact management of cattle for prevention of disease. Subclinical hypocalcemia affects 47% of multiparous dairy cows and increases risk of developing other diseases as well as depressed milk production and reproductive performance. The objective of this study was to evaluate the performance of the on-farm i-STAT Portable Clinical Analyzer® and IDEXX VetTest® for calcium measurement with a Veterinary Diagnostic Laboratory as the reference method, and to investigate the relationship between total calcium (TCa) and ionized calcium (iCa) and their effect on neutrophil oxidative burst activity. Holstein dairy cows (n=33) were blood sampled daily for five days postpartum and calcium status was monitored. There was a high correlation between on-farm tools and the reference method of measurement in a laboratory, though determination and use of a corrected cutpoint for diagnosis improved the relationship. The on-farm TCa measure's corrected cutpoint was 8.9 mg/dL and the on-farm iCa measure was corrected to 4.68 mg/dL. Ionized calcium was 57% of TCa during the first 24 hours postpartum. Ionized calcium was significantly correlated with neutrophil oxidative burst activity, and had a higher correlation coefficient than TCa at 12 and 24 hours postpartum and at the lowest measure of calcium throughout the sampling period. These results imply that iCa may be the more accurate measure for diagnosis of SCH, but the relationship between TCa and iCa must be better characterized before iCa alone should be used for diagnosis of SCH.

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## Peanut Allergy Immunotherapy Via Sustained Delivery of Pathogen-mimetic Particles

KAHO E. MINETA

Under the supervision of Dr. David Putnam and Joseph Rosenthal  
Department of Biomedical Engineering

Clinical cases of food allergy amongst children and adults of the western world are increasing at alarming rates, particularly in peanut allergy. Ineffective and insufficient methods for managing and preventing severe peanut-induced allergic reactions are imposing a significant public health concern. To improve modern management techniques for allergic patients, this work tested molecularly engineered peanut antigen carriers derived from *Escherichia coli* outer membrane vesicles (OMVs) encapsulated in a sustained dosage form as a novel immunotherapeutic for peanut allergy. Here, we show that OMVs can effectively and efficiently target peanut antigens to key immune cells that provide protective functions against the induction of severe, potentially life-threatening allergic reactions, such as anaphylaxis. When treated with our peanut antigen-delivery system via OMVs, peanut-sensitized mice were effectively protected against anaphylactic symptoms. Our data indicates



several advantages of our antigen-delivery system over current treatment modalities, including improved safety profile, decreased adverse side effects, and enhanced compliancy. Overall, our results suggest that encapsulated OMV-based immunotherapy is a promising alternative in the management and prevention of severe allergic reactions.

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### *In vitro* assay in *Trichinella spiralis*

MAURA C. RUYECHAN

Under the supervision of Dr. Judith Appleton  
Baker Institute for Animal Health

The parasitic nematode, *Trichinella spiralis*, colonizes and mates in the small intestine of susceptible hosts. How male worms are able to locate females in this habitat is a question that remains unanswered. We hypothesize that males detect small signaling molecules, called ascarosides, which the female releases. To test this hypothesis a chemotaxis assay was created by modifying a method developed to study parasite development. Epithelial monolayers were grown in dishes, overlaid with a mixture of agarose and medium and a male worm was placed in a center well. After a time sufficient to allow invasion of the monolayer, either a female, another male, or supernatant from cultured females was placed in a half-well in the agarose at a distance of 20 mm. Migration of male worms was quantified by image capture and measurement of the trails using ImageJ software. Results from these experiments showed that males were attracted to the females ( $p=0.04$ ), and strongly so in the first quartile of migration ( $p=0.02$ ). Male worms were neither attracted nor repelled by other males. Supernatant trials were inconclusive. In parallel experiments, ascarosides produced by *T. spiralis* have been detected by mass spectrometry. Overall, the results show that female *T. spiralis* attract male worms and the assay offers promise as a tool for evaluating drugs or vaccines that target the reproductive cycle of parasitic worms.

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### Inactivation of *Toxocara canis*, *Toxocara cati*, and *Trichuris vulpis* Eggs by Exposure to Short-chain Fatty Acids (SCFA)

KRYSTA M. SCIMECA

Under the supervision of Dr. Dwight D. Bowman  
Department of Microbiology and Immunology

Toxocariasis is a highly prevalent infection in humans by the parasite *Toxocara canis*, the common roundworm of canids. It has previously been shown that the eggs of *Ascaris suum*, a related nematode of swine, can be killed by exposure to a solution of short-chain fatty acids (SCFA). In the experiments presented here, parasite eggs were obtained from the feces of naturally infected hosts, isolated using centrifugal fecal flotation techniques, and exposed to SCFA to determine their rate of inactivation. The dog whipworm, *Trichuris vulpis*, and the common cat roundworm, *Toxocara cati*, were also tested to attain a practical sanitizing method for veterinary and human purposes.

Most effective at higher temperatures, butanoic and hexanoic acid treatments at maximum solubility did not reduce egg viability after 120 minutes at both 4 or 22° C. At 37° C, eggs reached zero viability for *Toxocara* sp. after 15 minutes, and for *Trichuris vulpis* after 75 minutes of treatment with hexanoic acid at maximum solubility. For butanoic acid at this temperature and maximum solubility, eggs reached zero viability for *Toxocara canis* and *Toxocara cati* after 45 minutes of treatment, and for *Trichuris vulpis* after 60. Above solubility at 37° C, hexanoic acid (1.5M, pH4) prevented all eggs from reaching their infective stage after 10 minutes of treatment for *Toxocara canis*, *Trichuris vulpis*, and *Toxocara cati*. Although these findings are not practical for use in a hospital, further investigation should work to replace hazardous chemicals currently used to reduce soil contamination by geohelminths.

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## Magnesium Promotes *in vitro* Capacitation and a Progesterone-stimulated Biphasic Intracellular Calcium Response in Canine Spermatozoa

SKYLAR R. SYLVESTER

Under the supervision of Dr. Alexander J. Travis  
James A. Baker Institute for Animal Health

Live offspring have never been produced from *in vitro* fertilization (IVF) in the dog despite decades of attempts and routine use in humans. In our efforts to develop this powerful assisted reproductive technology (ART), we first attempted IVF using *in vivo* matured oocytes, as prior experiments have typically used *in vitro* matured oocytes of variable quality. We found no significant improvement in cleavage rates, which led us to question whether the problem stemmed from deficiencies in how canine sperm are capacitated *in vitro*. We incubated sperm under conditions thought to promote capacitation, the acquisition of fertilization competence, in modified canine capacitation medium (mCCM) supplemented with 0, 0.1, or 1mM magnesium chloride (MgCl<sub>2</sub>). We found that the addition of magnesium positively impacted sperm motility, protein tyrosine phosphorylation, hyperactivation and progesterone-induced acrosome exocytosis after 4 hours of capacitation. We used fluorescence calcium imaging of single sperm to investigate the molecular mechanism by which magnesium might support these processes. After 4 hours of capacitation with 1mM MgCl<sub>2</sub> a significantly greater percentage of individual sperm cells responded to progesterone, exhibiting a biphasic influx of calcium and higher rates of acrosome exocytosis. Together, these results suggest a function for magnesium in regulating capacitation and acrosome exocytosis in canine sperm, at least in part by modulating calcium influx. Our findings run counter to the conditions commonly used to capacitate dog sperm for the past 3 decades, and this difference might help explain the historical lack of success with *in vitro* fertilization in this species.

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## Identification of Major Histocompatibility Complex Haplotypes in Icelandic Horses

NATHANIEL P. VIOLETTE

Under the supervision of Dr. Douglas Antczak  
James A. Baker Institute for Animal Health

The Major Histocompatibility Complex (MHC) is a region of the vertebrate genome that encodes many immune-related proteins. The most well-known proteins that are encoded in this region are the MHC class I and MHC class II cell surface proteins. These proteins are integral in producing the adaptive immune response. Using polymorphic microsatellites within the MHC, MHC haplotypes were characterized from an extended Icelandic horse family of half and full siblings. The herd is composed of one stallion, fifteen dams, and three sets of foals from each dam. A total of nine microsatellite loci were tested: two in the MHC class I region, two in the MHC class III region, and five in the MHC class II region. The Icelandic herd displayed a large degree of diversity in this region even though the population has been isolated and affected by bottleneck events in the past. From the 32 possible unique haplotypes belonging to the one founder stallion and 15 mares, 26 unique haplotypes were identified. A MHC recombination event occurred on one of the paternal chromosomes. The stallion also exhibited segregation distortion in the distribution of the stallion's MHC haplotypes inherited by the foals but not the sex ratio of the offspring. These findings suggest that the Icelandic horse population has a greater degree of diversity in the MHC region than most other commonly studied horse breeds. This diversity may come from a recombination mechanism that produces unique haplotypes by crossing over of existing haplotypes in the population at a higher rate than found in larger populations. Another possible explanation would be that less favorable MHC haplotypes are allowed to persist in the less immunologically selective environment of Iceland.

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## Development of an Impact Injury Model for the Equine Talocrural Joint

SHANNON K. WALSH

Under the supervision of Dr. Lisa A. Fortier  
Department of Clinical Sciences

Osteoarthritis is a highly prevalent and often debilitating joint disease, affecting over 27 million people in the United States alone. While arthritis development is common in the knee, this disease also affects the ankle, a joint which almost exclusively develops osteoarthritis post-trauma. There is a significant lack of information regarding the progression of this disease and a subsequent lack of preventative or regenerative therapies to treat those affected. There is a pressing need for a viable animal model for testing potential treatments for this condition. The morphological similarity between the talus of the equine talocrural joint and that of the human makes the equine an attractive candidate to fill this role. The first step to developing this model is to validate a method of creating superphysiological impacts synonymous with naturally occurring injuries causative of osteoarthritis in humans. In this study, we sought to accomplish this task through impacting the equine talus *in vitro* using a custom-made mobile impacting device. Mechanical force and displacement data were acquired, and samples were subjected to histological analysis of structural damage, cell death, and proteoglycan depletion. Comparison of mechanical data with the existing literature showed that this mobile impactor is capable of delivering impacts thought to be necessary to simulate natural injury of articular cartilage. The benefit of this new impactor is its ability to be used *in vivo*, opening up a window of opportunity for future translational research of post-traumatic osteoarthritis.

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## Using a Soil Isotope Chronosequence to Quantify Symbiotic Nitrogen Fixation during Woody Plant Encroachment in a Subtropical Savanna

SHAUNTLE R. BARLEY

Under the supervision of Dr. Jed Sparks  
Department of Ecology and Evolutionary Biology

Encroachment of woody plants into savannas and grasslands is frequently driven by nitrogen (N) fixing leguminous trees. This process is associated with significant increases in soil N in these previously nutrient poor systems. Long-term biological N fixation is difficult to measure directly, so it is unclear how much new N comes from fixation, rather than from processes such as increased deposition. In this study, we used the unique establishment patterns of legume tree *Prosopis glandulosa* in the Rio Grande Plains to estimate rates of N fixation and total N additions over time. Over a soil chronosequence representing 144 years of encroachment, we measured spatially explicit  $\delta^{15}\text{N}$  natural abundance to estimate what proportion of soil N was derived from fixation by *Prosopis glandulosa*. We found that soil %N increases linearly, four fold above initial levels after 144 years of encroachment. Up to 18% of this N ( $0.004 \text{ kg N yr}^{-1}$  per tree at  $T=104$ ) was derived from fixed N inputs at 0 %, with total N fixation input being at most 2.8 kg fixed N per tree over 144 years. However, this estimate is likely very conservative as we cannot yet account for enrichment of N between fixation and incorporation into soil organic matter. Further development of this novel estimation method is highly desirable, both generally for investigating N fixation and more specifically to estimate the impacts of woody legume encroachment on terrestrial biogeochemical cycling of N and ecosystem N balance.

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## Interspecific Information Use by Army-ant-following Birds

HOPE J. BATCHELLER

Under the supervision of Dr. Irby Lovette  
Department of Ecology and Evolutionary Biology

Many animals use cues from other species to gather information about foraging locations, but engaging in such behaviors requires balancing the potential benefits with the risks of increased competition. Neotropical birds that follow army ants are a particularly appropriate system in which to study such eavesdropping behaviors. These understory birds congregate around army ant swarms, where they forage on insects flushed by the ants. Obligate ant-followers have specialized behaviors to track the ants and may serve as information providers to facultative ant-following species. Due to dominance relationships, however, the value of this information likely depends on the competitive relationship between the information provider and eavesdropper. I investigated whether ant-following birds preferentially follow the songs of some antbird species over others, testing the prediction that vocalizations of small (subordinate) ant-following birds would attract more birds than vocalizations of large (dominant) birds. I conducted playback experiments that broadcast the songs of the small Bicolored Antbird (*Gymnopithys leucaspis*), the larger Reddish-winged Bare-eye

(*Phlegopsis erythroptera*), and a control that does not attend ant swarms (Peruvian Warbling-Antbird, *Hypocnemis peruviana*). Heterospecific individuals responded significantly more to the playbacks of Bicolored Antbird compared to both Reddish-winged Bare-eye and the control. This difference may be due to Bicolored Antbird's favorable combination of subordinate status and far-carrying song. These two factors (competition and cue prominence) are also important determinants of information utility in analogous systems involving other taxa. These dynamics of interspecific information use by ant-following birds may provide insights into the general mechanisms involved in forming and maintaining mixed-species foraging aggregations.

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## Investigating the Role of FANCI in Mammalian Germ Cell Development

ALYSSA J. CORNELIUS

Under the supervision of Dr. Paula Cohen  
Department of Biomedical Sciences

Fanconi Anemia (FA) is a recessive genetic disorder found in humans, characterized by chromosomal instability, and a profound sensitivity to agents that produce DNA interstrand cross-links. The FA family, consisting of at least 15 genes, is involved in germ cell development in mice. *Fanci* is the most recent gene in this family to be targeted for mutagenesis in mice. It is widely known that FANCI interacts with MLH1, which is an essential factor promoting meiotic crossovers. To determine the role of FANCI in meiosis and gametogenesis, a thorough meiotic phenotypic analysis was performed on a series of adult *Fanci* mutant mice, including analysis of testes size, sperm number, meiotic spreads and immunofluorescent staining. While the *Fanci* mutants showed smaller testes and lower sperm numbers, meiotic progression was normal. Thus, we concluded that the defects in sperm number and testis size were not the result of meiotic errors, but instead might be the result of embryonic defects. It is suspected that the extremely rapid rate of proliferation of germ cells during mid-to-late gestation renders them particularly susceptible to DNA damage, and may account for the phenotype observed in the adults. It is hypothesized that FANCI plays a critical role in establishing the appropriate population of spermatogonial stem cells in the testis during embryonic development such that loss of *Fanci* leads to dramatically reduced testis cellularity and decreased spermatozoa output by the testis. Consequently, a thorough germ cell analysis was performed on the embryonic *Fanci* mutant and control mouse testes, including analysis of the number of primordial germ cells and apoptotic cells. There was a severe decrease in the number of primordial germ cells and a significant increase in the amount of apoptosis in the mutant embryos of ages e14.5, e17.5 and days one and five postpartum, leading to the conclusion that *Fanci* indeed plays some role in establishing the appropriate population of spermatogonial stem cells.

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## Growth of the Psychrotolerant Halotolerant Bacterium *Psychrobacter* sp. in the Mammalian Gut

HANNAH N. DE JONG

Under the supervision of Dr. Ruth E. Ley  
Department of Microbiology

Bacteria play an important role in the mammalian gut, performing functions that the host cannot. In an initial survey of fecal samples from captive and wild polar bears, I observed greater gut microbial diversity than expected based on published data. I also observed a possible pattern of colonization by an environmental bacterium in the psychrotolerant, halotolerant genus *Psychrobacter*. Here I perform a series of experiments in vitro and in vivo in a mouse model that together indicate that a *Psychrobacter* sp. isolated from polar bear feces is capable of colonizing the gut of a laboratory mouse. I sequenced the isolate's genome and found genetic evidence that it has acquired functions necessary to survive in the gut environment. These results together with evidence from prior studies support a mammalian gut niche for *Psychrobacter* sp., typically considered a polar environmental bacterium.

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## Olfactory Network Activity During Novel Odor Investigation

OWEN R.C. DEAN

Under the supervision of Dr. Christiane Linster  
Department of Neurobiology and Behavior

Cholinergic input to the olfactory system serves a critical role in olfactory perception, although very little is known about its actual modulation during behavior. Computational models hypothesize that cholinergic projections from the Horizontal Limb of the Diagonal Band of Broca (HDB) to the piriform cortex (PC) and olfactory bulb (OB) increase memory robustness and have a role in novel odor perception. To further investigate how the HDB, OB, and PC interact during behavior, we collected local field potential (LFP) and single unit spike data from these three regions simultaneously in rats during a simple novel odor nose poke paradigm. The preliminary LFP results identify multiple frequency bands of LFP activity in the HDB and dynamic synchrony in between neural oscillations the OB, PC, and HDB during novel odor investigation and open field exploration. These results, although far from complete, support current computational models of the olfactory network and further define the role of cholinergic modulation in sensory perception.

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## Targeted Screen for Functional Interactions between $\beta$ -tubulin and +TIP Mutants in *Saccharomyces cerevisiae*

DEMITRI DEDOUSIS

Under the supervision of Dr. Tim Huffaker  
Department of Molecular Biology and Genetics

The microtubule cytoskeleton is involved in key cellular processes, including cellular polarization and transport. Microtubules are composed of repeating  $\alpha$  and  $\beta$  tubulin dimers. TUB2 is an essential yeast gene that encodes  $\beta$ -tubulin. Microtubule polymerization dynamics in yeast are regulated by +TIPs, like Bim1p and Bik1p. Genetic analysis of multiple genes concurrently allows for the identification of interactions between genes. This study seeks to investigate interactions between Bim1p/Bik1p and Tub2p by using random spore analysis (RSA) to search for synthetic interactions caused by the association of *bim1* $\Delta$ /*bik1* $\Delta$  and *tub2* mutants. Using the RSA results and a set of criteria, *tub2* mutants were grouped into interaction types, such as synthetic sensitive and synthetic enhanced. This study also investigated associations between a *tub2* mutation's interaction type and other *tub2* phenotypes, which revealed an association between synthetic sensitivity and cold sensitivity for *tub2* and *bik1* $\Delta$ . A protein model of *tub2* mutations in  $\beta$ -tubulin was also used to demonstrate that *tub2* mutations that did not interact with *bim1* $\Delta$ /*bik1* $\Delta$  tended to cluster together in the same location on  $\beta$ -tubulin. This study shows that RSA can be used to identify synthetic interactions, which can be analyzed in terms of protein structure and relationship with other traits of the mutations.

The microtubule cytoskeleton is involved in key cellular processes, including cellular polarization and transport. Microtubules are composed of repeating  $\alpha$  and  $\beta$  tubulin dimers. TUB2 is an essential yeast gene that encodes  $\beta$ -tubulin. Microtubule polymerization dynamics in yeast are regulated by +TIPs, like Bim1p and Bik1p. Genetic analysis of multiple genes concurrently allows for the identification of interactions between genes. This study seeks to investigate interactions between Bim1p/Bik1p and Tub2p by using random spore analysis (RSA) to search for synthetic interactions caused by the association of *bim1* $\Delta$ /*bik1* $\Delta$  and *tub2* mutants. Using the RSA results and a set of criteria, *tub2* mutants were grouped into interaction types, such as synthetic sensitive and synthetic enhanced. This study also investigated associations between a *tub2* mutation's interaction type and other *tub2* phenotypes, which revealed an association between synthetic sensitivity and cold sensitivity for *tub2* and *bik1* $\Delta$ . A protein model of *tub2* mutations in  $\beta$ -tubulin was also used to demonstrate that *tub2* mutations that did not interact with *bim1* $\Delta$ /*bik1* $\Delta$  tended to cluster together in the same location on  $\beta$ -tubulin. This study shows that RSA can be used to identify synthetic interactions, which can be analyzed in terms of protein structure and relationship with other traits of the mutations.

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## Adiponectin Influences Fat Taste Perception

JAKOB DOBROWOLSKI

Under the supervision of Dr. Robin Dando  
Department of Food Science

Our sense of taste is vital in determining food choice and preference. Obesity, characterized by excess caloric consumption, diabetes, excess blood sugar, and hypertension, and exacerbated by increased sodium intake, are all diseases vulnerable to dysregulation through food intake. Circulating peptides and hormones can influence our sense of taste, and therefore, our dietary intake. An important molecule in control of feeding, levels of which are profoundly altered in metabolic disorders such as obesity, is adiponectin. Adiponectin is involved in the control of feeding behavior, and in the metabolic breakdown of fatty acids and other nutrients, and subsequent utilization of fatty acids. Preliminary studies in our lab indicate the presence of adiponectin receptors in the taste bud. We investigated the effects of adiponectin on taste perception and preference.

Behavioral studies using adiponectin KO mice show drastically modified taste responses to linoleic acid, the most common free fatty acid in our diet, when compared to the responses of wildtype (C57) controls. Davis Lickometer assays and twobottle preference tests show C57 mice have a preference for fatty taste, a wellpublished phenomenon similar to that seen in humans. Adiponectin KO mice meanwhile, show no preference for any concentration of linoleic acid, confirmed in parallel experiments with 2bottle preference testing. We hypothesize that this may be due to adiponectin being an upstream regulator of expression of the putative fat receptor CD36.

Metabolic disorders are caused primarily by overconsumption, directed by our sense of taste. An imbalance in hormones can promote obesity, and can influence both our taste perception and dietary consumption. Hormonal supplementation may offer new approaches and targets for therapeutic intervention in the treatment of obesity.

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## Identification of Pollen Collected by Honey Bees (*Apis mellifera*) and Bumble Bees (*Bombus impatiens*) in Pumpkin Fields

ALEXANDRA GRESOV

Under the supervision of Dr. Brian Nault  
Department of Entomology

Pollination is an essential ecological service critical to the success of many agricultural crops. However, bees placed in crop fields for pollination have been known to leave the field to collect pollen from more favorable sources. Honey bee, *Apis mellifera*, and bumble bee, *Bombus impatiens*, hives were placed in each of five commercial pumpkin fields and pollen brought back to the hive was examined in order to determine foraging fidelity of the bees to pumpkins. Pollen was removed and identified from their corbiculae, pollen-transporting structures on the hind leg, or on their



bodies, which likely occurred accidentally during a nectar foraging event. Pollen was collected from the corbicula of ten individuals returning to the hive in each of three sampling events from each field, and identified to the lowest possible taxonomic classification using a pollen reference library. Pollen from asteraceous plants (37%) was most commonly collected by honey bees, while pollen from fabaceous plants (34%) was most commonly collected by bumble bees. Pumpkin pollen collected by honey bees and bumble bees comprised only 1% and 0.7% of pollen brought back to the hive, respectively. These results suggest that factors other than proximity, such as nutrient content, pollen depletion by competing pollinators, or both, influence bees' decisions about where to forage for pollen. Results also suggest that supplementation of commercial crops with either honey bees or bumble bees may not always be beneficial for crop yield.

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## Racing Through Life: Effects of Density-dependent Maturation on Overcompensation and Persistence of Harvested Populations

VADIM A. KARATAYEV

Under the supervision of Dr. Clifford Kraft  
Department of Natural Resources

Phenotypic plasticity allows populations to respond to environmental changes much more rapidly than evolutionary processes. A profound example of this are rapid, density-dependent changes in age-at-maturity, which could affect the dynamics of harvested populations. In this study I use a two-stage, discrete-time model to show that adult density-dependent maturation rates dampen or eliminate overcompensation, a scenario in which control of an undesired species through harvest backfires with an increase in population size. However, stage-specific harvest strategies could elicit or amplify the strength of an overcompensatory response. My results also demonstrate that density-dependent increases in maturation rates allow populations with low survival rates to persist under much greater harvest pressures and maintain higher levels of adult abundance, but have only mild effects for species with high juvenile survival. These trends were persistent across a wide range of vital rates and across all harvest regimes examined. Removal efforts of nuisance or invasive species with low juvenile survival rates should consider the possibility and magnitude of compensatory responses in age at maturity to mortality, which can amplify the harvest effort required to reduce or collapse these populations. On the other hand, when survival and per capita recruitment rates are high, density-dependent recruitment and maturation rates should be carefully considered in avoiding an overcompensatory response to harvest. Finally, density-dependent maturation rates among species with low survival rates are likely to have a greater influence than evolutionary adaptation in allowing populations of ecological or commercial value to persist under high levels of harvest or predation.

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## Populations of Alewife, *Alosa pseudoharengus*, in Lakes of Central New York

ELIZABETH M. KELLER

Under the supervision of Dr. Lars Rudstam  
Department of Natural Resources

Alewives, *Alosa pseudoharengus*, have invaded many lakes in upstate New York. Although the species strongly affect ecosystem dynamics, there is only limited information on variability in growth, condition, and reproductive rates among populations. Alewives were collected using beach seines and gillnets during the spawning season of 2013 in seven New York lakes: Canadarago, Cayuga, Cross, Onondaga, Ontario, Otisco, and Owasco Lakes. Length, weight, age, condition, and gonadosomatic index (GSI) varied significantly across populations. Age at maturity varied among populations, most often at ages 2 to 3, with two populations with portions maturing at age 1. Those populations maturing earlier were associated with higher GSI or growth rates and greater weight to length relationship. Analysis of genetic sequences of the mitochondrial control region presented Canadarago Lake as a differentiated group among the lakes studied suggesting a different source population and may explain the larger size and growth rates of alewife in that lake. These results demonstrate differences among northern alewife populations and call for more study to determine further indication of causes.

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## An Electrophysiological Study of the Adult Zebrafish Heart: The Effects of Hypocalcemia, L-type Calcium Channel Blocker, and Sarcoplasmic Reticulum Calcium Release Inhibitor on Electrical Restitution

HYUNYOUNG G. KIM

Under the supervision of Dr. Robert F. Gilmour, Jr.  
Department of Biomedical Sciences

The slope of the action potential duration (APD) restitution relation and alteration of intracellular calcium dynamics have been proposed as crucial determinants of APD alternans, a long-short alternation of APD that has been linked to the initiation of the lethal heart rhythm disorder ventricular fibrillation. However, investigations of the mechanism(s) for APD alternans have been hampered by the lack of an appropriate experimental model, in particular a model in which adult cardiac myocytes can be studied *in vitro* before and after genetic manipulation of the ion channels, transporters and pumps that underlie restitution and calcium dynamics. Given that the zebrafish heart has been shown to hold some promise as a suitable model to study cardiac cellular electrophysiology, we tested whether APD restitution is responsible for APD alternans by determining the effects of interventions that block calcium dynamics but either increase (hypocalcemia) or decrease (verapamil) the slope of the APD restitution relation. We also directly tested the hypothesis that calcium dynamics are responsible for APD alternans by blocking the sarcoplasmic reticulum (SR) calcium release channel using ryanodine. Verapamil reduced the slope of the APD restitution relation and suppressed APD alternans, whereas alternans persisted in hypocalcemic conditions ( $[CaCl_2] = 125 \mu M$  and  $62.5 \mu M$ ). In contrast, ryanodine markedly dampened, but did not abolish, APD alternans. Thus, the APD restitution relation and intracellular calcium dynamics are inter-related and both appear to contribute to the development of ventricular fibrillation in the zebrafish heart, observations that further support the utility of the zebrafish heart as an experimental model for human myocardium.

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## The Effects of Hive Size on Swarming, Mite Density, Disease, and Mortality in Honey Bee Colonies Infested with *Varroa* mites

JON C. LOFTUS

Under the supervision of Dr. Thomas D. Seeley  
Department of Neurobiology and Behavior

The ectoparasitic mite, *Varroa destructor*, and the viruses that it transmits, are killing the colonies of honey bees kept by beekeepers unless the bees are treated with miticides. Nevertheless, feral colonies of honey bees have persisted without treatments in several locations around the world despite being infested with *Varroa* mites. We hypothesized that because feral colonies occupy smaller nesting cavities and so probably swarm more often than managed colonies, they experience a natural method of mite control. To test this hypothesis, we established two groups of 12 colonies living either in small (42 L) hives or in large (168 L) hives. We followed the colonies for two years to compare the two groups with respect to frequency of swarming, density of mites, incidence of disease, and mortality. We found that colonies in small hives were more likely to swarm, had lower mite densities, and had less disease compared to colonies in large hives. These results suggest that the smaller nesting cavities and the higher incidence of swarming of feral colonies are at least partially responsible for their better survival than managed colonies. This study points toward sustainable methods of beekeeping that control the mites in honey bee colonies without treating them with pesticides.

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## Using Arterial and Lymphatic/Venous Specific Markers to Unmask Organ-specific Vascularization in the Dorsal Mesentery of *Gallus gallus*

CHRISTINE M. LY

Under the supervision of Dr. Natasza Kurpios  
Department of Molecular Medicine

The relatively simple and conserved structural development of the gastrointestinal tract offers itself as an excellent model system to study organ-specific vascularization to better understand the role of the vascular network in cancer metastasis. Leftward tilt of the dorsal mesentery (DM), the tissue suspending the primitive gut tube from the abdominal wall, initiates coiling. In the left DM, arterial dorsal-ventral cords form early in development. A few days later, these cords begin to recede as a new anterior-posterior vessel forms. I have used RNA in situ hybridization with probes specific to arterial and lymphatic/venous markers to better understand the events underlying the development of intestinal vasculature. My goal is to not only understand how this primary AP vessel subsequently remodels and branches to vascularize the elongating intestines, but to also investigate the initiation of lymphatic and venous vessel formation.

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## Retention of Woody Material to Enhance Forest Regeneration

DEVIN E. MCMAHON

Under the supervision of Dr. Stephen J. Morreale and Kristi L. Sullivan, Extension Associate  
Department of Natural Resources

Inadequate regeneration of new trees reduces the density and diversity of forest canopies, impairs the establishment of resilient multi-aged forest, and poses major problems for the future of forests across the northeastern United States. A significant barrier to regeneration is the extensive browsing of seedlings by deer, exacerbated by competition from less palatable plants. One management practice that may promote forest regeneration is retention of woody material on the forest floor following tree harvest, with material consolidated in loose piles that exclude deer. To test this approach, we implemented a controlled block design at three forested stands in Central New York, where harvests were conducted within a sustainable forest management framework. Within each stand, three 1.44-ha treatment plots were constructed: high, medium, and minimal retention of woody material. Within each plot, we established paired sample areas with and without woody material, where we measured species composition and diversity, abundance, and size structure of regenerating trees, and the proportion of regenerating stems browsed by deer. Sample areas containing woody material showed reduced deer browsing of seedlings under 1 m tall and increased proportions of seedlings reaching taller height classes. On the treatment level, increased woody material retention was associated with increased abundance of regeneration, although inter-stand variation was substantial. In addition, woody material was associated with increased species diversity among seedlings on sample and treatment scales. Our results suggest that leaving consolidated woody material on the forest floor promotes regeneration and represents a good investment in future forests.

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## Reliable and Sensitive Predictors of Conversion from Mild Cognitive Impairment to Alzheimer's Disease

NICOLE K. MEYERS

Under the supervision of Dr. Charles J. Brainerd  
Department of Human Development

Alzheimer's disease (AD) was estimated to affect 4.7 million individuals in 2010, with an expected growth to 13.8 million in 2050 (Hebert et al., 2013). This projected increase in prevalence emphasizes the need to better understand the factors controlling the transitions during the pathological aging process. An important area of research is an intermediate stage known as mild cognitive impairment (MCI). Those individuals with MCI have a substantially greater risk of developing AD, making this a critical stage for further investigation. The present study analyzed various biospecimen markers, brain-imaging markers, and cognitive markers, in order to assess their ability to reliably predict conversion from MCI to AD. A large focus was on the use of markers that are measured using low-cost and non-invasive techniques, such as neuropsychological testing. The results of this study replicated established findings regarding the reliability of AD markers, such as

the apolipoprotein E genotype and levels of the  $\beta$ -amyloid and  $\tau$  proteins in the cerebrospinal fluid. In addition, estimates of recall operations obtained from standard clinical memory tests, as well as scores on certain neuropsychological tests, were also accurate predictors of conversion from MCI to AD. When some of those markers were combined, there was an improvement in accuracy as compared to when the markers were used individually. Generating sets of markers that most accurately predict MCI to AD conversion provides additional insight into the disease progression, and potentially allows for more effective interventions to either delay the progression to AD or reduce its characteristic symptoms.

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## Microtubule Dynamics of $\beta$ -tubulin Mutants in *Saccharomyces cerevisiae*

STEPHEN R. SAMMONS

Under the supervision of Dr. Tim Huffaker  
Department of Molecular Biology and Genetics

Microtubules are an integral part of the Eukaryotic cytoskeleton. They are composed of  $\alpha$ -tubulin and  $\beta$ -tubulin proteins that assemble into polarized protofilaments which associate laterally to form hollow tubes. Microtubule dynamics are regulated by a wide array of microtubule associated proteins and can be modified for research and therapeutic purposes by microtubule targeting agents. Studying amino acid substitutions in the  $\beta$ -tubulin protein can inform research into the complex process of microtubule dynamics. Herein I report the effect of two  $\beta$ -tubulin amino acid substitutions on microtubule dynamics in *Saccharomyces cerevisiae*. A double mutation intended to block polymerization, T175R V179R, conferred mild changes to microtubule dynamics, possibly due to a destabilization of the mutant protein. A single mutation intended to disrupt an ionic interaction in  $\beta$ -tubulin, R241F, suppressed microtubule dynamics and reduced total polymerized tubulin. A disruption of the curved conformation assumed by the free  $\alpha/\beta$  tubulin heterodimer is proposed as a mechanism to explain R241F's effect.

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## Identifying a Novel Protein Involved in Mitochondrial Inheritance in *S. cerevisiae*

KLASKE M. SCHUKKEN

Under the supervision of Dr. Anthony Bretscher  
Weill Institute for Cell and Molecular Biology

Mitochondria are essential organelles in all eukaryotes, and inheriting mitochondria from the mother cell is an essential process. In *Saccharomyces cerevisiae*, there are several proteins that are known to be involved with the mitochondrial inheritance process, including MYO2, MMR1 and YPT11. Mmr1p and Ypt11p are receptors for the Myosin-V motor protein Myo2p, which is known to transport the mitochondria into the bud. When one of these two proteins is deleted, mitochondria are still inherited, but when both proteins are non-functional, mitochondria are not inherited and the daughter cells cannot mature.

To discover novel genes involved with this pathway, we performed an overexpression suppression screen in budding yeast. The strain used is *mmr1-20 ypt11Δ*, a double mutant that does not inherit mitochondria at the restrictive temperature. The screen isolated a novel gene, YJL118w, which rescues the temperature sensitive growth deficiency of this double mutant. We have named this gene RYM1 (Rescues *ypt11Δ mmr1-20*).

Transmembrane prediction programs and localization experiments indicate that RYM1 is a mitochondrial membrane protein. Overexpression growth assays and fluorescence experiments show that Rym1p overexpression significantly rescues *mmr1-20 ypt11Δ* growth deficiency by increasing mitochondrial inheritance. Thus we have discovered a new player in the essential mitochondrial inheritance pathway in *S. cerevisiae*.

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## The Role of Cyclic-di-AMP and ppGpp in Antibiotic Resistance and the Characterization of Suppressors of c-di-AMP Essentiality in *Bacillus subtilis*

FARIDA A. TANKO

Under the supervision of Dr. John D. Helmann  
Department of Microbiology

Cyclic di-adenosine monophosphate (c-di-AMP) is a recently discovered bacterial second messenger in *B. subtilis*, and its depletion leads to defects in the integrity of the cell wall. The roles of c-di-AMP are not well understood, but recent results suggest that it is, directly or indirectly, involved in peptidoglycan homeostasis. Levels of c-di-AMP are regulated by both the rates of synthesis (by diadenylate cyclases DisA, YbbP and YojJ) and the rates of degradation (by GdpP phosphodiesterase, formerly YybT). GdpP is inhibited by ppGpp *in vitro*. The bacterial alarmone, ppGpp, is a global regulator responsible for stringent control in *B. subtilis*. RelA, YjbM and YwaC synthesize ppGpp in *B. subtilis*. Here, we demonstrate that the mutations that inactivate *relA*, *yjbM*, and *ywaC* lead to sensitivity to  $\beta$ -lactam antibiotics and this effect requires GdpP. Genetic studies indicate that at least one c-di-AMP synthase is required for growth with its depletion leading to cell lysis. These findings support the idea that these enzymes (RelA, YjbM, and YwaC) play an important role for c-di-AMP in  $\beta$ -lactam resistance and cell wall stress in *B. subtilis*, and suggest that the levels of c-di-AMP are controlled in part by ppGpp.

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## Identification of Elements Critical to the Function of ESCRT-III

LEONID A. TIMASHEV

Under the supervision of Dr. Scott Emr  
Weill Institute for Cell and Molecular Biology, Department of Molecular Biology and Genetics

The Endosomal Sorting Complex Required for Transport (ESCRT) machinery is critical for sorting ubiquitinated transmembrane proteins at endosomes and converting them into multivesicular bodies (MVBs). The ESCRT machinery accomplishes this by directly driving the formation of intraluminal vesicles (ILVs) at the surface of the endosome. The role of the ESCRT-III complex in ILV

formation has generally been well-characterized, and it has been shown that ESCRT-III is necessary and sufficient to form ILVs. However, the role of Bro1 (an ESCRT-III accessory protein) in ILV formation has not been well studied. This thesis will address ILV formation by the ESCRT-III complex from three different angles, working with the yeast *Saccharomyces cerevisiae* as a model organism. First, we will examine the role of Bro1 in binding the Bro1 Binding C-Terminus (BBC) of Snf7, the main filament protein in the ESCRT-III complex. Next, we will examine the role of N-terminal modifications of ESCRT-III subunits on ILV formation. Finally, we will explore the often-overlooked role of the cargo itself on ILV formation. Our data has shown that Bro1 must bind to a specific, conserved region of Snf7 to promote ILV formation and functional sorting of cargo. We have also shown that different N-termini of ESCRT-III subunits have varying tolerances for lipid-anchoring myristol modifications. To conclude, we provide evidence that cargo size is not important in promoting ILV formation. Taken together, these results shed further light on the mechanism of ILV formation by the ESCRT-III complex.

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## Start to Finish Detection of *Cryptosporidium* for in Field Use on Water Samples via Lauroylsarcosine sodium Salt (LSS) Extraction, Loop Mediated Isothermal Amplification (LAMP), and DNA Precipitation

EMILY WESSLING

Under the supervision of Dr. Dwight Bowman  
Department of Microbiology and Immunology

Today, many diseases that are rare in developed nations are still prevalent in other countries due to limited technological access and resources. Among these diseases is Cryptosporidiosis, a common gastro-intestinal infection with currently no known treatments. Cryptosporidiosis is caused by the parasite *Cryptosporidium*. This parasite spreads through the environment as an oocyst, causing self-limiting diarrhea in healthy humans. These symptoms are often more dangerous in immunocompromised individuals and children, whose immune systems are still developing. The rugged *Cryptosporidium* oocysts are able to survive treatment with most disinfectants. Thus, to prevent outbreaks, there must be early detection, followed by rapid treatment of the water supply and/or limited exposure to infected water supplies. Current methods of parasite testing for water samples are limited in their function by cost, access to materials, and ability to run equipment. Improvements in cost-effective, easy to use alternatives to traditional techniques, such as the use of lauroylsarcosine sodium salt (LSS) for DNA extraction and the loop mediated isothermal amplification (LAMP) method of amplification, will facilitate the detection of *Cryptosporidium* in the field and in impoverished nations. In this experiment, a five primer LAMP reaction was used in combination with the LSS reaction to eliminate otherwise essential electrical equipment in the detection process, expediting and easing in-field detection. The LSS was found to decrease the efficiency of the LAMP reaction, but its effects were mediated by changing the buffer used in the LAMP reaction. Amplicons were visualized using gel electrophoresis in this experiment. However, methods of detection were tested for incorporation into the test. These techniques will lead to the future of cost efficient detection of *Cryptosporidium* in water samples.

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## Characterization of Vascular Development in the Dorsal Mesentery of the Gastrointestinal Tract

TINA WU

Under the supervision of Dr. Natasza A. Kurpios  
Department of Molecular Medicine

Vascular development during embryogenesis is critical to proper organogenesis of all vertebrates and has to be coordinated with the formation of each organ. A vascular network is made up of three flavors of genetically and functionally distinct vessels: arteries, veins and lymphatics. Understanding the formation of how this vascular network is established will enable us to better understand its role in disease-states such as cancer, where the vascular network is the primary route for metastasis of tumor cells, especially in the gut mesenteric vasculature. Here, I have shown that lymphatic and/or venous development might follow arterial vasculogenesis in the dorsal mesentery, a mesodermal structure that suspends the gut tube and drives proper gut morphogenesis. Further work is needed to distinguish gut lymphatics from veins and determine their embryonic origin.

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## Changes in the GABAergic System of the Lumbar Spinal Cord After Complete Spinal Transection in the Mouse: Immunohistochemical Analysis of GABA and Its Synthetic Enzyme, Glutamate Decarboxylase (GAD)

PHILINA YEE

Under the supervision of Dr. Ronald Harris-Warrick  
Department of Neurobiology and Behavior

After spinal cord injury (SCI), the spinal cord becomes drastically altered due to loss of supraspinal control below the lesion and due to homeostatic changes in spinal networks. Our lab has examined some of these changes in the mouse hindlimb central pattern generator (CPG), located in the upper lumbar spinal cord. The hindlimb CPG is responsible for rhythmic motor output such as locomotion. GABA plays an important role in central nervous system, and participates in the hindlimb CPG through inhibitory interneurons. 40% of descending inputs from the brainstem are GABAergic which are lost through complete spinal cord transection. In cats, the rate-limiting synthetic enzyme for GABA, glutamate decarboxylase (GAD), has been reported to be upregulated in the lumbar spinal cord after complete spinal cord transection. However, our immunofluorescence experiments found a significant decrease in GAD in the ventral horn of the mouse upper lumbar spinal cord after SCI. Interestingly, GABA immunoreactivity showed no decrease in the ventral horn after SCI.



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## Submarine Groundwater Discharge as a Local Facilitator of the Coral Disease, *Porites* growth anomalies, in West Hawai‘i

REYN M. YOSHIOKA

Under the supervision of Dr. C. Drew Harvell  
Department of Ecology and Evolutionary Biology

Coral reefs along Hawai‘i Island’s leeward coast (West Hawai‘i) are the best-developed reefs in the Main Hawaiian Islands but face local anthropogenic stress through development, direct damage, and submarine groundwater discharge (SGD), the primary source of pollutants entering reefs. In West Hawai‘i, *Porites* genus corals are the dominant reef-building corals and the most susceptible to disease, most common of which is the coral disease syndrome *Porites* Growth Anomalies (PGAs). To test the hypothesis that SGD and associated pollutants affect coral disease, I studied the spatial and temporal patterns of PGAs in three regions of West Hawai‘i in relation to SGD inputs. In Kailua and Kaloko-Honokōhau, where SGD inputs occur largely from single sources, I assessed PGAs at varying distances from the inputs. I analyzed a year-long time series of PGA photographs, finding both PGA area and partial mortality increased over time. Along gradients from SGD sources, the size of PGAs decreased with increasing distance, though only significantly in the Kailua region. PGA growth rate did not differ significantly along either gradient. In Puakō, where SGDs are more diffuse, I compared the spatial patterns of PGAs to metrics of sewage pollution. PGA prevalence and severity differed significantly between 10 sites, though highly variable metrics of sewage pollution did not. Nonetheless, PGA severity was predicted by shoreline *Enterococcus* density, implicating sewage pollution as a factor in coral disease. This research shows that SGD likely contributes to coral disease, but that other factors including coral demography and site architecture also play significant roles.

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## Age, Inbreeding, and Fine Scale Spatial Structure—Not Kinship—Influence Gut Microbial Communities in a Hindgut Fermenting Tortoise

MICHAEL L. YUAN

Under the supervision of Dr. Kelly R. Zamudio  
Department of Ecology and Evolutionary Biology

Herbivorous vertebrates rely on complex communities of mutualistic gut bacteria to facilitate the digestion of celluloses and hemicelluloses. Convergence of microbial communities has been observed in a phylogenetically diverse group of mammalian herbivores and appears to be driven by diet and digestive morphology. Here I expand upon studies of gut microbiomes within herbivorous hindgut fermenting reptiles to further explore the composition of microbial communities associated with obligate herbivores. I characterize the fecal microbial community of a population of gopher tortoises, *Gopherus polyphemus*, and examine how age, genetic diversity, spatial structure, and kinship influence differences among individuals. I find that the gut community of the gopher tortoise is highly convergent with that of hindgut fermenting mammals. I recover several OTUs associated

with known cellulolytic groups suggesting their importance in gopher tortoise herbivory. Additionally, I find no evidence of similarity in fecal communities based on kinship or heterozygosity. However, I find evidence that fine-scale spatial structure, ontogenetic shifts, and inbreeding affect within-population fecal microbiomes of gopher tortoises. My findings suggest the widespread convergence of feces-associated microbes based on gut morphology and diet, and demonstrate the importance of spatial and demographic structure in driving differentiation of gut microbiota within natural populations.

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## Attention Deficit Hyperactivity Disorder (ADHD) in the United States and Latin America: Similarities, Differences, and Relevance of Biological and Socioeconomic Factors for ADHD Prevalence Rates

DAVID LIENDO URIONA

Under the supervision of Dr. Kathleen Vogel  
Department of Science & Technology Studies

This research examines the definition, evolution, and factors comprising Attention Deficit Hyperactivity Disorder (ADHD) in a comparative perspective by looking at how this condition is viewed in the United States, Europe, and Latin America. It is a complex disorder that is intertwined with factors such as genes, neurochemistry, neuroanatomical variations, and the environment, which makes its diagnosis and treatment challenging. Most professionals in America use the ADHD checklist found in the Diagnostic and Statistical Manual of Mental Disorders (DSM), which was developed by the American Psychological Association. In contrast, professionals in Europe use the World Health Organization's International Statistical Classification of Disease (ICD). Both tests have similar criteria for diagnosis with only a few differences, both checklists are also problematic in terms of how they can assess ADHD. In recent years the prevalence of ADHD in the United States has increased dramatically, leading to discussions that it is an epidemic unique to western culture. One concern with an increase in ADHD diagnoses is that pharmaceutical companies could benefit financially from these increased diagnoses, with a subsequent targeting of individuals for pharmaceutical intervention to treat this condition, which could also lead to side effects and health risks for children. In addition, there also seem to be particular socio-cultural factors that can shape the interpretation of behavioral conditions like ADHD. The findings of this research showed the challenges in diagnosing ADHD and how these arise from particular historical and scientific contexts. In addition, this thesis provides a detailed comparative description of knowledge about ADHD between the United States and Latin America, and some of the problems that arise from relying on the DSM and ICD checklists. Finally, the thesis offers some recommendations for how to proceed with ADHD diagnosis and treatment.

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## Impact of Sandy and Well-drained Soils on the Richness and Abundance of Soil Nesting Bees in Apple Orchards in Central New York

JULIA N. BROKAW

Under the supervision of Dr. Bryan Danforth and Mia Park, PhD candidate  
Department of Entomology

Pollination by wild bees provides important pollination services for many economically important crops. However, landscape factors that contribute to suitable nesting habitat are not well understood for many ground-nesting species. Focusing on apple pollination, we studied the soil composition of 19 orchards across New York State. We defined suitable nesting soils as being well-drained and greater than 30 percent sand. Through geospatial analysis, we determined how proportion of suitable soil surrounding orchards at different spatial scales affected bee species richness, ground nesting bee abundance, and presence of individual species. There were no significant effects of the proportion of suitable ground-nesting bee soils in and around apple orchards on the richness and abundance of ground-nesting bee species. These results helped to quantify soil characteristics and demonstrated that if land managers want to use geospatial data to model or predict ground-nesting bee populations, incorporating more variables and using higher resolution datasets are needed.

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## Ontogenetic Changes in Behavior of *Podisus maculiventris* (Heteroptera: Pentatomidae) and its Effects on the Behavior of the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Coleoptera: Chrysomelidae)

STEPHEN PECYLAK

Under the supervision of Dr. Jennifer Thaler  
Department of Entomology

The major objectives of this study were: 1) to determine whether adult and/or nymphal *P. maculiventris* stinkbugs change larval Colorado Potato Beetle behavior, 2) to determine whether solitary nymphs or nymphal aggregations were enough to cause changes in Colorado Potato Beetle Behavior, and 3) to determine if the different life stages and presence of an aggregation alter the foraging behavior of *P. maculiventris*.

Potato plants were set up containing a 4<sup>th</sup> instar Colorado Potato Beetle (CPB) and assigned to one of four treatments: no *P. maculiventris*, one adult female *P. maculiventris*, one nymphal *P. maculiventris*, and three nymphal *P. maculiventris*. Each plant was watched continuously for one hour, for a total of 59 replicates. All instances of resting, moving, and eating behavior were recorded for the CPB, while all instances of resting, moving, plant feeding, and CPB feeding behavior were recorded for the *P. maculiventris*.

This study demonstrates that both aggregations of nymphs and adult *P. maculiventris* can reduce the ratio of eating to resting in 4<sup>th</sup> instar CPB larvae. By looking at the behavior of the CPB before, during, and after the first attack was made, it was shown that most of these behavioral changes were concentrated after the first contact with the *P. maculiventris* nymphal was made, but only for the nymphal aggregations. The study also demonstrates that *P. maculiventris* behavior does not change much between the adult and nymphal instars as previously thought, and both life stages are equally efficient predators.

This study serves as a basis for further exploration on the effects of *P. maculiventris* on CPB. This has implications for potential uses of *P. maculiventris* in biocontrol and starts to unravel how CPB are responding to their environment. Finally, it shows that the different life stages of *P. maculiventris* are not as different as previously thought and should be explored more closely.

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## Colony Inheritance and Fights to the Death among Sisters in a Prolonged Subsocial Spider

MARI A. WEST

Under the supervision of Dr. Linda S. Rayor  
Department of Entomology

Colony founding is a challenge faced by social organisms that need to establish new social groups and it often leads to conflict in groups otherwise characterized by peaceful cooperation. The prolonged subsocial huntsman spider, *Delena cancerides* (Sparassidae), lives under the bark of dead trees, in colonies composed of a single adult female and her offspring from multiple cohorts. Most individuals disperse at sexual maturity and compete for a limited number of available retreats, but some females remain in their natal colony and attempt to inherit it from their mother. Field evidence demonstrates that a single daughter inherits and breeds in a retreat. In this laboratory study, we observed the dominance hierarchy among penultimate and adult sisters and how colony inheritance in this species is controlled. Our results and analysis suggest that, when forced to stay together, mimicking their highly saturated habitat in the wild, *D. cancerides* sisters transition from tolerant cooperation to aggression and cannibalism, battling for the dominant position of the solely breeding female. Ultimately, this results in the death of all but one, or occasionally two, females. This can be closely compared to the strategy employed by pleometrotic ants, bees, and thrips. Though these two strategies share many similarities, there are a few notable differences between them – the battle for dominance in pleometrotic/secondary monogyny species occurs among unrelated females that cooperate to establish colonies in harsh and/or competitive conditions, while in *D. cancerides* it occurs among sisters. This pattern of colony inheritance is unknown in other social spiders.

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## Visitor's Study at the Museum of the Earth in Ithaca, NY: Evaluating the Effectiveness of the Coral Tanks

LILY EISERMANN

Under the supervision of Dr. Bruce Lewenstein  
Department of Communication

This study examined the time allocation of visitor attention at the Museum of the Earth in Ithaca, New York, at the Coral Reef Tank exhibit. The goal of the study was to determine which aspects of the exhibit the visitors focused on the most and which parts of the exhibit did not engage the attention of visitors as much. To better understand visitor interaction with the exhibit, both observational data and verbal visitor responses were recorded and analyzed. Of over 100 visitors observed, few of them (around 35%) read the exhibit information panels and even fewer (just over 3%) read the information monitors that provide nearly all the educational content of the exhibit. The verbal survey data (although it is a very small sample size compared to the observed visitors) aligns with the observational data collected.

Additionally, the verbal survey data provided insights into what information the visitors retained from the exhibit. For example, the majority of the verbal respondents could not share any information that they learned from the exhibit. This answer, and answers to the other survey questions made clear that the exhibit is not functioning as well as it could be. Based on the information collected about which aspects of the exhibit the visitors focused their attention on and the verbal survey responses, there are clear recommendations for the exhibit set up. These recommendations deal mainly with the placement of and the content on both the information monitors and the information panels.

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## Lessons Learned from an Agroforestry Alternative Livelihood Initiative in Andean Ecuador

EVAN M. BARRIENTOS

Under the supervision of Dr. James P. Lassoie  
Department of Natural Resources

Alternative livelihoods are a crucial component of conservation and are thought to play a key role in reducing pressure on nature reserves from neighboring communities. However, alternative livelihoods are much more complicated in practice than in theory, and can fail spectacularly if complex technical and cultural factors are not considered. In this study I researched an alternative livelihood initiative that introduced shade-grown coffee as a sustainable alternative livelihood for farmers encroaching upon a large cloud forest remnant in Andean Ecuador. The success of this initiative has been greatly hampered by low coffee production, farmer apathy, and abandonment. These failures are due principally to inadequate funding/timescale of the initiative and cultural incompatibility with the introduced alternative. The results demonstrate that for alternative livelihoods to succeed, implementers must fully understand the cultural compatibility of the alternative, ensure that participants understand the non-financial benefits of the alternative, and plan for long-term commitment.

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## Impacts of Deer and Invasive Earthworms on Native Ferns of Northeastern Forests

AUDREY E. BOWE

Under the supervision of Dr. Bernd Blossey  
Department of Natural Resources

Forests in the northeastern USA have experienced heavy browsing from the native white-tailed deer as well as the invasion of non-native earthworms from Europe and Asia. Although studies have examined deer and earthworm impacts on plants independently, here I examined the interactive effects that exist between these two important drivers of ecosystem change. I focused on four common ferns, and expected that Hayscented fern, Marginal Wood fern, and Christmas fern would be able to resist deer and earthworms, whereas Maidenhair fern would be negatively impacted by earthworm presence. I used complementary laboratory and field studies. In the laboratory-based experiment, several fern species were exposed to different earthworm species treatments. In the field, ferns were planted into plots with varying worm and deer conditions. Overall, in both the field and controlled laboratory experiments, when significant interactions were found, earthworms and deer had relatively minor cumulative effects on the survival of mature fern sporophytes. As expected, Hayscented fern, Marginal Wood fern, and Christmas fern had high survival rates, whereas Maidenhair fern had low survival regardless of treatments. The work implies that, even though direct effects in mature sporophytes were not detected, earthworm activity could be impacting fern populations at other points in their life history.

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## Fidelity of Death vs. Live Assemblages Using Xanthid Mud Crabs from Louisiana Gulf Coast Oyster Reefs

THOMAS W. BUTLER

Under the supervision of Dr. Gregory Dietl  
Department of Earth and Atmospheric Sciences

Environmental reconstruction is a useful tool for determining ecosystem changes over time. One such tool fitted to environmental reconstruction is a live-dead comparison that utilizes the preservable hard parts of both living and death assemblages. Live-Dead comparisons (L-D) have traditionally focused on mollusks due to easily preserved hard part morphologies. However these species are not the only hard-shelled organisms. A plethora of other environmental data can be teased apart from other taxa. Two species of xanthid mud crab, *Eurypanopeus depressus*, and *Panopeus herbstii*, are species of arthropods with hard mineralized parts. The difference between these shells and that of mollusks is that with mollusks hard parts can disarticulate into two even sized halves. In arthropods segments of varying size easily disarticulate causing issues with size-frequency distribution comparisons between both live and death assemblages. Using previously collected bulk samples containing both live and dead crab dactyls were measured. Corrections were made by designing an experiment to replicate the probabilities of claws falling through the size sieve used to sort the sample initially. Based off corrections from this experiment it was determined that the fidelity between L-D assemblage comparisons for the arthropod species *E. depressus*, and *P. herbstii* was very low and unreliable for comparisons between living and dead size frequency distributions.

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## Evaluating the Influence of Abiotic Factors on Brook Trout (*Salvelinus fontinalis*) Feeding and Zooplankton Community Structure in Adirondack Lakes

LYNDSIE M. COLLIS

Under the supervision of Dr. Clifford E. Kraft  
Department of Natural Resources

Increased water temperature has been shown to decrease brook trout (*Salvelinus fontinalis*) foraging during the summer months. However, the relationship between lake stratification and brook trout feeding has not been examined. As summer temperatures in the Adirondacks continue to increase, stratification may be eliminated entirely in shallow lakes that currently stratify. Brook trout might be more highly influenced by increased temperatures in smaller, shallower lakes that remain thermally unstratified throughout the summer than those in thermally stratified lakes that provide access to thermal refugia. If brook trout in unstratified lakes forage less, then *Daphnia* spp. (a prey item for brook trout) should be larger and more abundant. Increased feeding by *Daphnia* would lower phytoplankton levels, which would be reflected in increased secchi depths. Brook trout diets, zooplankton tows, and secchi depths for three stratified and two unstratified lakes were analyzed to determine if brook trout in unstratified lakes exhibited the predicted decrease in feeding behavior



due to greater thermal stress. Brook trout diets, *Daphnia* mean size and abundance, and secchi depths were not significantly different between stratified and unstratified lakes. The lack of significance could be due to variations of fish species present within the lakes, the presence of invertebrate zooplankton predators such as *Chaoborus*, or the fact that brook trout are not obligate planktivores and can therefore consume alternate prey sources. This study indicates that lake stratification likely does not have a significant effect on brook trout foraging or on *Daphnia* communities, but multiple factors must be considered when examining the influence of lake stratification on an aquatic ecosystem.

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## The Influence of Leaf Litter Decomposition on Microbial Methanogenesis in a Forested Wetland: The Importance of Tree Species Identity

ELIZABETH M. CORTESELLI

Under the supervision of Dr. Joseph B. Yavitt  
Department of Natural Resources

This study evaluated the relationship between plant species identity and microbial methane production in a forested wetland in New York State. Leaf litter that falls to the wetland floors is the main energetic input for microbial methane producers (methanogens), and thus the amount of methane produced should be related directly to litter quantity and quality. I evaluated leaf litter quality in terms of the rate of decomposition and the carbohydrate constituents of the litter itself. I hypothesized that the leaf litter from gymnosperms (pines, spruces, among others) would fuel more methane production by providing more structural organic molecules over a longer decomposition period. To test this a three year field study of leaf litter decomposition was done using fifteen different tree species. Residue was collected yearly, the amount of mass loss was determined, and I used the residue to quantify methane production through in vitro incubation and carbohydrate composition through a seven-step chemical extraction method. As expected, leaf litter decomposed more quickly for angiosperms than gymnosperms. Gymnosperms had a greater proportion of structural compounds, which allowed them to fuel more methane production after a year of decomposition, when these compounds are released. These results suggest that gymnosperms do indeed have the potential to fuel more methane production than angiosperms. A better understanding of the relationship between methane production and litter quality will allow for more accurate forecasting of methane production in wetlands based on knowledge of plant species alone.

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## New York City's Oyster Gardeners: Memories, Meanings, and Motivations of Volunteer Environmental Stewards

SARAH R. CRESTOL

Under the supervision of Dr. Marianne E. Krasny  
Department of Natural Resources

I conducted a study to determine the motivations of volunteer oyster gardeners in the New York City estuary, and the memories, meanings, and sense of place they associate with their work. Oyster gardeners are individual or groups of volunteers who place cages with young oysters at locations agreed upon with the non-profit NY/NJ Baykeeper, and monitor the oysters' growth and survival. Open-ended interviews were conducted with ten oyster gardeners and transcripts were iteratively coded to understand specific motivations, social-ecological memories and meanings, and sense of place. Oyster gardeners' social-ecological memories of and meanings related to oysters and the NYC estuary were tightly intertwined with their sense of place and motivations. These links suggest that whereas altruistic concern related to improving the environment is an important motivation for environmental volunteerism, the specific focus of environmental volunteerism may be driven by social-ecological memories, meanings, and sense of place derived from experiences with and the features of local places and species. In some cases, this process may rise to the level of creation or recognition of iconic species, which could create additional leverage points for environmental volunteerism, including ecological and socio-cultural meanings attributed to species as well as fascination and related aspects of biophilia. In short, altruistic values centered on the environment may be an underlying factor or primary motivation, whereas sense of loss coupled with memories, meanings, and sense of place may be a precipitating factor or selective motivation in environmental volunteerism.

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## Zinc and Cadmium Uptake by the Hyperaccumulator plant *Phytolacca americana*

MEREDITH R. FRENCHMEYER

Under the supervision of Dr. Murray McBride  
School of Integrative Plant Science

Although most of the research on heavy metal-accumulating plants focuses on their ability in phytoremediation, it is equally important to understand the mechanisms behind metal accumulation in plants. Here I explored the feasibility that Cadmium (Cd) substituted into calcium oxalate crystals, replacing calcium (Ca), allowing the Cd to be sequestered within the plant and chemically unavailable. Because calcium oxalate's insolubility, oxalate crystals might also be able to sequester other phytotoxic metals, such copper, lead, and zinc. I used *Phytolacca americana*, which is one of only a select few plants that have been identified as hyperaccumulators of Cd. I examined the interactions between Ca and Cd using aqueous solutions conducive to forming calcium oxalate crystals, and I found a linear relationship between the ratio of Cd/Ca in solution (at equilibrium) and the Cd/Cd in the oxalate crystals at equilibrium. In contrast, tendency for Zn to co-precipitate into Ca oxalate was much lower. The precipitates from the Cd and calcium oxalate solution reactions were inspected by optical microscopy and analyzed by X-ray diffraction to determine their crystal morphologies and mineral structures. The change in crystal shape and formation suggested that Cd displaced calcium. Several plants were grown with Cd and Zn in both a greenhouse and field, and *P. americana* accumulated much greater concentrations of both metals compared to the plants grown in control soils. The results showed that Cd substitutes into calcium oxalate crystals potentially providing an effective mechanism of Cd sequestration in pokeweed (and other high-oxalate plant species) and inhibiting phytotoxicity.

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## The Effects of a Large-Scale Smallmouth Bass Removal on the Growth of Pumpkinseed Sunfish

PATRICK T. KELLY

Under the supervision of Dr. Clifford E. Kraft  
Department of Natural Resources

The large-scale removal of introduced predators has been shown to have positive effects on native littoral fish communities as they are released from an unnatural predation pressure. In many fish species, utilization of resources is shown as a trade-off between growth and reproduction, with those fish facing immense predation pressure putting more resources into growth to escape the threat of predation. A large-scale smallmouth bass (*Micropterus dolomieu*) removal effort in Little Moose Lake in the Adirondacks has been shown to increase the abundance of native fishes on a large scale. The population of pumpkinseed sunfish (*Lepomis gibbosus*) is one of the species that has been shown to increase in relative abundance following smallmouth bass removal. The release from mortality has resulted in changes in predation pressure as shown here. Smallmouth bass from 2012-2013 were compared to fish from 2003 as well as fish from two other lakes to show how changes in competition and predation have led to changes in the life history strategies of pumpkinseed. The results suggest that the release of competition has led to a population increase on such a large scale that fish now grow faster than they did in 2003 because of an increase in intraspecific competition.

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## Individual Attitudes and Their Influence on Tree Watering Behaviors: An Analysis of Street Tree Watering in Ithaca

DIANE F. LUEBS

Under the supervision of Dr. Shorna Broussard Allred  
Department of Natural Resources

Street trees are typically planted to increase the presence of nature in an urban environment; however, this does not work when the trees are unable to survive in their given conditions. If a city is not able to provide water for the trees, then tree mortality becomes an issue. In these cases, the responsibility of tree watering may lie on the residents. However, not all residents are interested in caring for trees, as cities often plant them without community input. This study uses urban forestry projects in Ithaca, NY as a case study to analyze the motivations behind tree-watering behaviors. Survey data showed that most residents were happy with the street trees and agree that street tree survival is important. Analysis revealed that residents would be more likely to water street trees if they had input during the planning process. Specifically, this includes input about tree species. These data also revealed that the biggest barrier listed was not disinterest or financial inability; instead, the biggest barrier was a lack of a water source near the trees. A clear understanding of these motivations and barriers can be used to effectively encourage residents to water street trees in future urban forestry projects.

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## Interactions between Forest Ecosystem Stressors: Whitetailed Deer Overabundance and Earthworm Invasion

ELIZABETH G. SIMPSON

Under the supervision of Dr. Bernd Blossey  
Department of Natural Resources

Disturbances in forest ecosystems include the overabundance of whitetailed deer (*Odocoileus virginianus*) and non-native earthworm invasion. Understanding interactions between these disturbances allows us to understand how forests respond to loss biodiversity in the present and future. My research examined earthworm abundance inside versus outside of fenced areas to exclude deer (exclosures) located in northeastern deciduous forests in Pennsylvania, New Jersey, New York and Delaware. I incorporated factors such as time since creation of the exclosure (exclosure age) and exclosure size. I predicted that excluding deer led to less worm abundance and total biomass, and that the effect would be more pronounced in larger, older exclosures. Overall, I did find fewer worms inside exclosures than outside. However, worm abundance was not dependent upon exclosure age, size, region, or any additive or interactive effects of these terms. One unexpected result was extreme variation in abundance among different sites, indicating that habitat plays an important role in a worm's abundance. While earthworm abundance decreases when deer are excluded from a forested area, future studies should focus on invasion patterns, their relation to habitat type, and why worms survive and thrive in certain environments but not others.

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## Fine Root Biomass and Belowground Carbon Allocation in Northern Hardwood Forests

REBECCA S. TERRY

Under the supervision of Dr. Timothy J. Fahey  
Department of Natural Resources

The fine root biomass in northeastern hardwood forests is greatly dependent upon soil fertility. It is suspected that in forest ecosystems with low nutrient availability, the trees will allocate more carbon belowground to increase nutrient acquisition. This study looks to evaluate this assumption and to explore possible effects of forest age on these relationships. Study sites contain three age class structures, with each site having different soil fertility. All sites are part of a larger, ongoing study that will eventually manipulate the soil fertility through nutrient additions. In addition, I evaluated the relationship between fine root biomass and soil respiration, expecting higher respiration in soils with more roots. Belowground carbon allocation was also estimated in each stand as the difference between a site's total soil respiration and above ground leaf litter fall. Understanding how these variables interact gives us a better picture of the processes that drive the forest ecosystem.

Advancing our understanding of carbon allocation becomes very important, especially since forests play a significant role in the global carbon flux. Results indicate that older stands contain more fine root biomass, as expected. N mineralization in the B-horizon was used as a measure of nutrient

availability and showed that poor quality sites contained more fine root biomass. Thus there was more belowground carbon allocation for these forest stands. The variation in total annual soil respiration was most strongly influenced by above ground litter fall. The amount of litter fall would impact heterotrophic respiration, and thus total soil respiration. N availability does indeed have a strong influence over the carbon allocation processes in Northeastern forests.

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## Differences in Filtration Rates of Zebra Versus Quagga Mussels Along an Experimental Temperature Gradient

ALICIA S. ZHAO

Under the supervision of Dr. Lars Rudstam and Dr. Rebecca Schneider  
Department of Natural Resources

Invasive species can impact the structure and function of inland waters, and impacts might be modified by water temperature. With a recent change in the composition and abundance of two competing invasive mussel species in the Laurentian Great Lakes region, the impact of climate change on the shift in the seasonal patterns of mussel filtering is unclear. Our goal was to compare filtration rates of zebra mussels, *Dreissena polymorpha*, and quagga mussels, *Dreissena rostriformis bugensis*, across a range of current and anticipated temperatures in Oneida Lake, a 207 km<sup>2</sup> shallow, polymictic lake in Central New York, USA. Filtration rate experiments were conducted at 2°C intervals from 2-30°C, and took place at the Cornell Biological Field Station located in Bridgeport, New York on Oneida Lake. The algae *Chlamydomonas reinhardtii* was used as the food source, and filtration rates were measured as a change in fluorescence, translated to chlorophyll-a concentrations, over a two-hour period. Results showed that zebra and quagga mussels exhibit a bell-shaped curve, peaking at 16 °C for both species, with average filtration rates of 0.04 L/mussel-h and 0.02 L/mussel-h, respectively. Filtration rates of zebra mussels consistently exceeded those of quagga mussels. Overall, ANOVA tests showed statistical significance for a temperature group effect, mussel type effect, and interactive effect of mussel type and temperature group. We predict that the combined effects of quagga dominance and climate change will lead to shifts in the seasonal filtering patterns of Oneida Lake. However, our results should be combined with long-term analyses of mussel survey and phytoplankton biomass data to determine impacts on the Oneida Lake ecosystem.

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## Short- and Long-term Flammability of Biochars

YIYUE (MARY) ZHAO

Under the supervision of Dr. Johannes Lehmann  
School of Integrative Plant Science

Biochar is becoming a commercial biomass-derived product that is transported, stored, and applied to land for environmental management. However, no information is available about its flammability that significantly affects how biochar can be handled. Given that biochar can have very different properties depending on how and from what it is produced, flammability may also vary significantly.

The flammability of biochar and its dependency on biochar properties were quantified for a range of biochars produced at different pyrolysis temperatures and as a function of time after production. None of the studied biochars (34 samples stored for at least two years under argon) qualified as flammable substances, assessed using the applicable UN method. The majority of biochars (67%) had no combustion front propagation distance at all. Almost all of the studied fast pyrolysis biochars (71%) had higher combustion distances, whereas most slow pyrolysis samples (80%) did not combust. The combustion of stored biochars increased with the amount of volatiles ( $r^2=0.27$ ,  $P<0.05$ ,  $n=11$ ; dominated by fast pyrolysis biochars:  $r^2=0.62$ ,  $P<0.05$ ,  $n=5$ ), typical of biochars produced at lower temperatures. In contrast, the combustion of biochars within minutes of production was higher for biochars made at 450°C than 350°C, but decreased to negligible levels within one hour. Short-term flammability may be a function of the amount of free radicals and surface areas that can react with oxygen, whereas long-term flammability after storage may be a result of the potentially flammable volatile matter and some still weakly explained mechanisms for high-ash dairy feedstock.

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## Satisfaction with an Online Weight Gain Intervention for Women during Pregnancy: e-Moms of Rochester

JIAYI XU

Under the supervision of Dr. Christine M. Olson  
Division of Nutritional Sciences

**Background:** Weight management during pregnancy is critical to health of both mothers and infants. Online weight management interventions have advantages of convenience, accessibility, and flexibility.

**Objective:** This paper examines the satisfaction of pregnant women with the weight management online intervention in the e-Moms of Rochester project and evaluates the satisfaction level by study arm and by demographic characteristic.

**Methods:** e-Moms of Rochester is a randomized controlled trial designed to help pregnant women achieve a recommended weight gain during pregnancy via an online intervention. The satisfaction survey was available online to the participants after their delivery. 942 out of 1512 pregnant women completed the satisfaction survey. Among the 942 participants, 621 women were in the intervention arm while the other 321 were in the control arm. The satisfaction level was measured on a 10-point Likert-scale from “0-strongly disagree” to “10-strongly agree”. A score of 0-4 was counted as low satisfaction, 5-7 as medium satisfaction and 8-10 as high satisfaction. Chi-square test and Mann-Whitney U test were used for evaluating representativeness, satisfaction level across website features, and comparison of satisfaction by study arm and by demographic characteristic.

**Results:** 70%-91.2% participants had a moderate to high satisfaction with different website features. However, 59.3% participants rated social support negatively. The Resources (mean=7.29) and Articles & FAQ (mean=7.28) had the highest satisfaction levels on helpfulness. The weight gain tracker was rated highest in terms of ease of use (mean= 8.35). The satisfaction levels of helpfulness of Resources and Reminder were significantly different by arm ( $p= 0.035$ ;  $p= 0.002$ ). Satisfaction levels for some website features were significantly different as well by demographic characteristic.

**Conclusion:** Overall, participants felt satisfied with the project website except for the aspect of social support. The sections of Articles & FAQ and Resources were the most helpful. Weight gain tracker was the easiest to use in the intervention group. The intervention group had higher satisfaction level with Resources and Reminder. Pregnant women, who were low-income, young, Hispanic, African American or had a lower education level, were more satisfied with the website features. And these women who were African American, young, with lower education, or with lower income, had significantly higher ratings of social support in this e-Moms Roc project.

## The Relationship Between Carbon Fluxes, Precipitation, and Soil Properties, Along a Climate Gradient, Kohala Volcano, Hawai'i

KATHRYN D. BLAND

Under the supervision of Dr. Louis Derry  
Department of Earth and Atmospheric Sciences

The Hawaiian Islands are home to pronounced environmental gradients produced by the interaction of high topography with prevailing NE tradewinds. In order to investigate the effect of changes in temperature and precipitation on soil and ecosystem processes, with the driving question asking which soil properties dramatically influence soil CO<sub>2</sub> efflux, we established a transect along the leeward (southwestern) flank of Kohala mountain, Hawai'i, on 350,000 year old basalt flows and ash deposits.

Site elevations ranged from 550 m to 1560 m over 6 km, with a corresponding mean annual precipitation (MAP) range from 700 mm to 2400 mm (Giambelluca et al. 2103). The highest sites are located in native mesic forest, while the low and intermediate elevation sites were on cleared pasture with non-native kikuyu grasses.

Observations were made in the months of March and April from 2010 to 2013. Measured properties at each site include pH, soil moisture, CO<sub>2</sub> efflux, and soil temperature. Volumetric water content ranged from 2% to 65% (fully saturated). Soil pH ranged from 7.6 to 3.6. At the lower elevation sites, soils contained carbonate while the low pHs at the high elevations indicate soil exchange sites occupied by H<sup>+</sup> and Al<sup>3+</sup>. Soil pHs are mostly between 6 and 7.5 up to ca. 1800 mm MAP, with no distinct trend with rainfall or elevation. Above 1800 mm MAP soil pH declines approximately linearly with increasing MAP, reaching values < 3.6.

Soil CO<sub>2</sub> efflux was measured using a LiCOR 6400 gas exchange system. Average soil CO<sub>2</sub> efflux rates are as follows: "Mesic pasture" has an average CO<sub>2</sub> efflux of 8.5 μmol m<sup>-2</sup> s<sup>-1</sup>, "mesic forest" has an average CO<sub>2</sub> efflux of 6.3 μmol m<sup>-2</sup> s<sup>-1</sup>, "lowland dry grassland" has an average CO<sub>2</sub> efflux of 1.2 μmol m<sup>-2</sup> s<sup>-1</sup>, "lowland dry forest – restoration" has an average CO<sub>2</sub> efflux of 2.8 μmol m<sup>-2</sup> s<sup>-1</sup>, and "lowland dry forest" has an average CO<sub>2</sub> efflux of 7.3 μmol m<sup>-2</sup> s<sup>-1</sup>.

Using the Kriging technique in ArcGIS, each site was given a yearly CO<sub>2</sub> efflux analogue, and the differences in CO<sub>2</sub> effluxes between the years were statistically significant. Rain gauge data was collected from NOAA Hydronet stations and The Kohala Center's Hobo locations to make correlations between locations across the mountain. Kahua (96) was best correlated with the Hobo gauges in high elevation gauges.

Soil efflux rates were positively correlated with rainfall in the pasture sites, presumably reflecting increased net primary production. Lower CO<sub>2</sub> efflux rates in the forest sites may reflect lower net primary productivity and/or soil saturation that drastically decreases gas diffusivity. The forest sites hold substantially more CO<sub>2</sub> both in the standing crop of biomass and in soil carbon than do the pasture sites at similar rainfall levels.



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## Isolation of Bacteria from Compost for Potential Use in Biodecaffeination

ROBERT DIVINE

Under the supervision of Dr. Alicia Orta-Ramirez  
Department of Food Science

Caffeine (1,3,7-trimethyl xanthine) is a bioactive compound present in common foods and beverages such as coffee, tea, and chocolate. Though many consumers value caffeine for its physiological effects, others may prefer decaffeinated products to avoid caffeine. Decaffeination technologies have a great economic and environmental impact; however, current methods have various disadvantages, such as cost, waste, and solvent use. Microbial methods, known as *biodecaffeination*, have been explored as alternatives. Various microbes that are able to metabolize caffeine have been isolated from coffee plant roots. To this point, compost has not been looked at as a potential source for decaffeinating microbes.

Our objective was to isolate and identify microorganisms from compost and to address their potential as biodecaffeinators. Compost samples were obtained and then grown in nutrient broth. Cultures were streaked onto a selective agar that contained caffeine as its only carbon source. Partial 16S rDNA sequences were obtained for a subset of the colonies isolated from the caffeine agar. Preliminary results suggested that the isolated strains were *Pseudomonas*, *Arthrobacter*, *Sphingobacterium*, *Streptomyces*, and *Paenibacillus*, and that they may be capable of metabolizing caffeine.

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## Study on CO<sub>2</sub> Backpulsing as a Means to Reduce Fouling in Sterile Microfiltration of Apple Cider

SHAN HUANG

Under the supervision of Dr. Carmen I. Moraru  
Department of Food Science

The major challenge in using microfiltration (MF) as a non-thermal processing method for clarification of apple cider is membrane fouling. Previous studies showed that backpulsing with CO<sub>2</sub> can effectively mitigate the formation of a fouling layer and improve permeate flux during MF of apple cider using 0.8 μm pore size MF membranes. Sterile MF of apple cider using 0.2 μm pore size membranes is of interest for commercial applications, but the process is also affected by membrane fouling. In this study, the effect of CO<sub>2</sub> backpulsing on the permeate flux during sterile MF of apple cider was investigated. Specifically, different combinations of backpulsing duration (1s, 2s, and 3s) and frequency (2 minutes and 3 minutes) were studied. A pilot scale MF unit equipped with a Tami ceramic membrane of 0.2 μm pore size was used. The MF process was conducted at a temperature of 6°C, a cross-flow velocity of 5.5 m/s and a transmembrane pressure of 159 kPa. Permeate was collected gravimetrically for 5.75 hours for each experiment. Permeate flux over time and relative flux changes were calculated. Higher flux values were obtained in sterile MF runs with high

frequency (every 2 minutes) and short duration (1s and 2s) CO<sub>2</sub> backpulsing (34.81 and 37.48 L/m<sup>2</sup>h, respectively at the end of the MF run), compared to MF without CO<sub>2</sub> backpulsing (32.49 L/m<sup>2</sup>h at the end of the MF run). Other combinations of CO<sub>2</sub> backpulsing frequency and duration resulted in lower flux than the control: 31.89 L/m<sup>2</sup>h for 3s/2min, 31.62 L/m<sup>2</sup>h for 1s/3min, 30.67 L/m<sup>2</sup>h for 2s/3min, and 31.91 L/m<sup>2</sup>h for 3s/3min. Yet, CO<sub>2</sub> backpulsing with high frequency (every 2 minutes) and short duration (1s and 2s) yielded significantly lower change in flux (41% and 58%, respectively) than that the low frequency and long duration combinations (87% for 3s/2min, 77% for 1s/3min, 78% for 2s/3min and 84% for 3s/3min), and control (74%). These results suggest that CO<sub>2</sub> backpulsing can be effective in mitigating membrane fouling during sterile microfiltration, but different frequency and backpulsing duration may be required depending on the duration of the MF run. This method has the potential to be used to as an economic method to increase the production yield in the juice industry.

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## An Investigation of Microclimatological Conditions along Elevation Transects Near Ithaca, NY

COLIN S. RAYMOND

Under the supervision of Dr. Arthur DeGaetano  
Department of Earth and Atmospheric Sciences

A field campaign was conducted in complex topography near Ithaca, NY with the aim of determining and describing both qualitatively and quantitatively the variables that affect nighttime temperatures there. Observations were compared against a weighted average of nearby private-weather-station readings and Rapid Refresh [RAP]-model gridpoint forecasts for the corresponding time periods. Local nowcasts or forecasts for locations along the transects — generated from a similarity analysis of station and transect-location metadata — showed generally poor skill, though the consistently greater errors at higher elevations suggest the potential for fruitful additional adjustments beyond the scope of this study. A distinct reversal in the upslope wind corresponding to lapse rates near the moist-adiabatic value supports the hypothesis of a triggered hilltop cold-air pool. Nights with strong potential-temperature inversions had remarkably similar synoptic-scale conditions, which bore the hallmarks of a valley inversion being entrained from above by warm southeast winds. Bolstering this hypothesis was the definite linear relationship found between observed lapse rates and region-wide temperature trends on clear nights, but not cloudy ones. To better account for these findings, a new forecast scheme was then implemented, combining regressions of observed along-transect lapse rates on upslope winds, modeled open-sky lapse rates, and region-wide temperature trends; it demonstrated improved skill over the station-based one, suggesting that further work to enable standardization of microclimatic forecasts based on a simple set of externally measured variables would be both possible and productive.

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## Dietary Zinc Deficiency Affects Blood Linoleic Acid: Dihomo- $\gamma$ -linolenic Acid (LA:DGLA) Ratio; a Sensitive Physiological Marker of Zinc Status *in Vivo* (*Gallus gallus*)

SPENSER REED

Under the supervision of Dr. Elad Tako  
Department of Food Science and USDA-ARS Robert Holley Center for Agriculture & Health

Zinc is a vital micronutrient used for over 300 enzymatic reactions and multiple biochemical and structural processes in the body. To date, sensitive and specific biological markers of zinc status are still needed. The aim of this study was to evaluate *Gallus gallus* as an *in vivo* model in the context of assessing the sensitivity of a previously unexplored potential zinc biomarker, the erythrocyte linoleic acid: dihydro- $\gamma$ -linolenic acid (LA:DGLA) ratio. Diets identical in composition were formulated and two groups of birds ( $n = 12$ ) were randomly separated upon hatching into two diets, Zn(+) (zinc adequate control, 42.3  $\mu\text{g/g}$  zinc), and Zn(-) (zinc deficient, 2.5  $\mu\text{g/g}$  zinc). Dietary zinc intake, body weight, serum zinc, and the erythrocyte fatty acid profile were measured weekly. At the conclusion of the study, tissues were collected for gene expression analysis. Body weight, feed consumption, zinc intake, and serum zinc were higher in the Zn(+) control *versus* Zn(-) group ( $p < 0.05$ ). Hepatic TNF- $\alpha$ , IL-1 $\beta$ , and IL-6 gene expression were higher in the Zn(+) control group ( $p < 0.05$ ), and hepatic  $\Delta^6$  desaturase was significantly higher in the Zn(+) group ( $p < 0.001$ ). The LA:DGLA ratio was significantly elevated in the Zn(-) group compared to the Zn(+) group ( $22.6 \pm 0.5$  and  $18.5 \pm 0.5$ , % w/w, respectively,  $p < 0.001$ ). This study suggests erythrocyte LA:DGLA is able to differentiate zinc status between zinc adequate and zinc deficient birds, and may be a sensitive biomarker to assess dietary zinc manipulation.

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## Climate System and Carbon Cycle Sensitivity to Historical and RCP8.5 non-CO<sub>2</sub> Anthropogenic Forcings in the Earth System Model CESM1-(BGC)

SARAH SCHLUNEGGER

Under the supervision of Dr. Natalie Mahowald  
Department of Earth and Atmospheric Sciences

Climate change is expected to alter the capacity of ocean and terrestrial sinks to take up atmospheric CO<sub>2</sub> thus providing a feedback to climate change. We use the Community Earth System Model (CESM1-BGC) to conduct a set historical and RCP8.5 experiments to test climate and carbon cycle sensitivity to non-CO<sub>2</sub> anthropogenic forcings. We confirm magnitudes of atmospheric carbon accumulation in historical and RCP8.5 simulations are driven predominately by the biogeochemical effects of fossil fuel and land use change, with differences amongst experiments being driven primarily through differences in land-to-air flux. Anthropogenic aerosols, ozone concentrations and nitrogen deposition have smaller but significant impacts on net surface-to-air carbon flux, and internal carbon and nitrogen terms of the terrestrial and oceanic carbon reservoirs. Sink enhancing contributions from anthropogenic aerosols and nitrogen deposition are projected to decrease by the end of the 21st century,

while sink diminishing contributions from anthropogenic ozone concentrations and land use change are projected to increase.

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## Assessment of the Tompkins County Highway Division's Salt Use for Winter Road Maintenance in High Impact Frozen Precipitation Events

ROOP K. SINGH

Under the supervision of Mark W. Wysocki, Senior Lecturer  
Department of Earth and Atmospheric Sciences

Snow is a mainstay of the winter, and sometimes spring and fall seasons in Tompkins County. The Tompkins County Highway Division (TCHD) uses various snow and ice control strategies to ensure human safety on county roads during frozen precipitation events. Using data from ten high impact freezing precipitation events during October-May from 2010-2013, this study aims to analyze the highway division's salt use as a function of elevation, temperature and precipitation type. Timing of salt application with respect to the timing of the event, and whether the precipitation changes phase from liquid to solid were both found to be important factors in the TCHD's decision making process. On average 1.99 tons of salt were applied for every inch of snow over a mile long section of road in Tompkins County. The total number of events that occur each winter, rather than the total inches of snowfall, appear to have a greater impact on the amount of money spent each year on winter maintenance. Therefore, it is important for the TCHD to consider how the frequency of frozen precipitation events will change in the future due to both natural and anthropogenic impacts on climate for long-term policy for snow and ice control in Tompkins County.

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## Sensitivity of the Community Earth System Model to Reanalysis Data in the Modeling of Mineral Aerosols

MOLLY BECKER SMITH

Under the supervision of Dr. Natalie Mahowald  
Department of Earth and Atmospheric Sciences

NCAR's Community Earth System Model (CESM) is a National Science Foundation/Department of Energy sponsored climate model, used by a wide range of scientific fields from atmospheric science to biogeochemistry. CESM can also be used as a chemical transport model, with winds based on reanalysis datasets. In this capacity, the model includes the simulation of desert dust, which is made up of soil particles suspended in the atmosphere. The simulation of this desert dust includes three main parts: the generation of dust in dry, unvegetated regions with high winds, its transport to other regions of the globe, and ultimately its wet and dry deposition out of the atmosphere. This paper attempts to examine the robustness of interannual variability in reanalysis-based simulations of aerosols, by using CESM in conjunction with three different reanalyzed datasets to model dust aerosol variability from 1990 to 2005. The datasets chosen were MERRA (Modern Era-Retrospective Analysis for Research and Applications), NCEP (National Centers for Environmental Prediction), and ECMWF (European Center for Medium-

Range Weather Forecasts). These simulations were then compared to aerosol observations from the AERONET (Aerosol Robotic Network) database. Overall, bulk aerosol dust concentration has remained fairly constant during this time period, although there are strong seasonal variations over particularly dusty regions. The model simulations by all three meteorological datasets show good correlations with observations, although they display differences from one another. Specifically, the three reanalyzed datasets produce very similar results in the northern hemisphere, but there are pronounced discrepancies in the southern hemisphere. The ECMWF driven simulation shows significantly higher variability and larger atmospheric dust concentrations than do either the MERRA or NCEP simulations. All in all, there is enough of a difference in global aerosol dispersal between the three reanalysis driven model simulations to conclude that choice of reanalysis dataset can significantly affect the simulation of interannual variability in dust.

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## Westward-Tracking Cyclones: A Climatology of Storms Similar to Hurricane Sandy

ZACHARY T. ZAMBRESKI

Under the supervision of Dr. Arthur DeGaetano  
Department of Earth and Atmospheric Sciences

Nicknamed the “storm of the century”, Hurricane Sandy was a highly unusual storm system that developed as a tropical hurricane in the Caribbean but became an extratropical cyclone as it merged with a strong mid-latitude system moving across the northeast United States. Instead of tracking to the northeast, Sandy took a sharp left turn off the New Jersey coast due to the presence of a negatively tilted trough and a strong upper-level ridge across the North Atlantic. The occurrence of “Superstorm” Sandy raises the question “how prevalent are these types of cyclones in the available record of meteorological data?” A historical climatology of storms similar to Hurricane Sandy was constructed from 1951 to 2012 using the NCEP-NCAR Reanalysis dataset to address this question.

A list of 3,082 candidate storms was created from the Reanalysis dataset. A climatology of twenty-five storms separated into five climatological classifications was constructed from this list using a system of several weighting schemes that emphasized different features that made Hurricane Sandy unique, including its location, central pressure, and direction of motion. The synoptic characteristics of these analogues in addition to global signals such as the NAO were analyzed additionally to note similarities and differences between these storms and Hurricane Sandy in an attempt to develop a better understanding of features that help to facilitate the motion of these westward-tracking cyclones. The results of this research demonstrate that westward-tracking cyclones generally make landfall at lower latitudes than Sandy due to the presence of above average 500 hPa anomalies farther to the south and west of the blocking high present during Sandy, and the best analogues to Sandy were generally extratropical in origin. The magnitude of Hurricane Sandy’s central pressure and its sharp westward turn make it a unique tropical and extratropical system in recent meteorological history.

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## Traits of Consumer Interest in *C. pepo*: Reverse Striping and Hull-less Seeds

NICK BIEBEL

Under the supervision of Dr. Michael Mazourek and Lindsay Wyatt  
Department of Plant Breeding and Genetics

Squash (*Cucurbita pepo*) is an important vegetable crop world-wide, but one for which relatively little research has been undertaken regarding consumer and market-related traits. This work had the goal of better understanding two traits of consumer interest in *C. pepo*: reverse striping, a rind pattern aesthetic, and hull-less seeds, a character influencing the potential of squash seeds as a harvestable snack food. In a population derived from a cross relevant to winter squash breeding, reverse striping inheritance was in agreement with two previously published systems. In a second population derived from a cross between a hull-less seeded pumpkin and an acorn squash, the edible portions of hull-less seeds were larger than the edible portions of hulled seeds, and data from the parents suggest higher levels of carotenoids and tocopherols in hull-less seeds. The conclusions of this work should provide preliminary information to guide the incorporation of these traits into breeding programs and make them available to consumers—the ultimate beneficiaries of breeding.

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## Mutant Analysis of Candidate Genes for Quantitative Resistance to Northern Leaf Blight in Maize

XINGYU LUO

Under the supervision of Dr. Rebecca J. Nelson  
Department of Plant Pathology and Plant-Microbe Biology

Quantitative disease resistance (QDR), conditioned by multiple small-effect loci, is believed to be a durable and agriculturally important form of plant resistance. However, the molecular mechanisms that control QDR remain poorly understood. QDR has been described for maize (*Zea mays* L.) resistance to northern leaf blight (NLB), a maize disease caused by *Setosphaeria turcica*. Two methods had previously been used to identify candidate genes for NLB resistance: genome-wide association (GWA) studies and fine mapping of quantitative trait loci. To validate a subset of the candidate genes, mutants were identified from the Uniform Mu (UFMu) project that corresponded to the candidate genes identified from GWA studies and from fine-mapping QTLs. We phenotyped 123 UFMu families in the field to find lines with significant differences in disease phenotype. Approximately 10% of the families tested yielded significant withinfamily differences in disease. Approximately 75% of those significant lines were derived from associations that fell within joint linkage mapping NLB QTL. One target gene showed a significant mutant phenotype. A putative remorin gene within the 22-kb finemapping QTL interval at maize bin 1.02 showed significant differences in NLB resistance between homozygous mutant lines and the homozygous wild-type lines. This provides strong evidence that the gene may contribute to the QTL located in maize bin 1.02. The gene had previously been shown to be more highly expressed in a resistant vs. susceptible line.

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## Virus-Induced Gene Silencing of Traits in the Developing Wheat Grain

JEFFREY L. NEYHART

Under the supervision of Dr. Mark Sorrells  
Department of Plant Breeding and Genetics

Virus-induced gene silencing (VIGS) is a useful tool for gene function studies wherein recombinant viruses containing endogenous gene transcripts trigger the host sequence-specific RNA degradation system. Barley stripe mosaic virus (BSMV) has been successfully utilized as a VIGS vector in wheat (*Triticum aestivum*), however nearly all studies have been limited to genes in vegetative tissue. Many important seed-focused traits could benefit from using VIGS, including seed color and seed dormancy, which are closely related insofar as white wheat is markedly more susceptible to pre-harvest sprouting than red wheat. The Gateway® cloning system was used to develop silencing constructs that targeted the *PDS* gene (regulates carotenoid biosynthesis; downregulation leads to photobleaching) in leaf tissue of the cultivar Chinese Spring. Photobleaching occurred rapidly and persisted in tissue inoculated with recombinant virus, while control plants showed limited to no symptoms. Gene transcript levels, measured by semi-quantitative reverse transcription (RT) PCR, showed a significant difference between the BSMV:GW-PDS plants and the control. Silencing in the developing grain targeted genes in the flavonoid biosynthesis pathway (which are critical for seed color), including a transcription factor (*Tamyb10*) that controls many of the flavonoid genes and is a purported component of a pleiotropic color-dormancy relationship. RT-PCR revealed a specific reduction in transcript of the *CHS*, *F3H*, and *DHFR* genes following inoculation with the BSMV:Tamyb10 construct. However, seed pigmentation was not noticeably different between experimental and control plants, while a germination index indicated no difference in seed dormancy. This investigation demonstrated the feasibility of knocking down genes in the developing grain, and the Gateway® system provided a rapid method of construct generation. Nevertheless, functional genomics studies of grain traits could benefit from further research into a refined VIGS system.

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## Models of Foreign Aid Allocation and Impact on Effectiveness: A Comparison of USAID Projects in Afghanistan and Pakistan

SARAH ALLIBHOY

Under the supervision of Dr. Parfait Eloundou-Enyegue  
Department of Development Sociology

Afghanistan and Pakistan have been the centerpieces of U.S. foreign policy for the past decade and the U.S. Agency for International Development (USAID) has been a key player in working towards achieving strategic objectives in both countries. As the U.S. prepares to transition security forces out of Afghanistan in 2014, the nature of the U.S. – Afghan and U.S. – Pakistani relationship is sure to change. Through a close, qualitative, review of seven development projects by USAID in Afghanistan and Pakistan along with a statistical analysis of more than 80 projects to determine the relationship between various key factors and project success rate, this paper explores the relationship between method of aid allocation and aid effectiveness in a region where U.S. development activities are closely linked to specific national security objectives. The outcomes of the development projects provide insight into development best practices and the mechanisms that must be in place in order for aid organizations to reach development objectives.

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## Rethinking Development: An Analysis of the Factors Underlying Millennium Development Goal Progress in sub-Saharan Africa

JESSICA HORST

Under the supervision of Dr. Parfait Eloundou-Enyegue  
Department of Development Sociology

Many countries in sub-Saharan Africa are not on track to achieve the Millennium Development Goals (MDGs). This thesis evaluates the determinants of success in meeting the MDGs, namely the role of classic development factors such as education, demographic factors, good governance, and contribution of natural resources. After multivariate regression analysis, this thesis concludes that the aforementioned factors (education, population, governance, and natural resource contribution) explain 65% of the variance in MDG progress ( $R^2 = 0.65$ ), and while good governance is found to be beneficial, the analyses show surprising results for the effects of education, age structure and natural resource availability. Some of these findings suggest a need to rethink differences between classic measures/ determinants of development versus MDGs. As 2015 approaches and the MDG era comes to an end, research on these topics is critical to better inform the future developmental agenda.



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## Can 140 Characters Affect How You Learn? Using Twitter to Encourage Active Learning in the Classroom

PATRICE M. LAWLESS

Under the supervision of Dr. Jeffrey T. Hancock  
Department of Communication

Previous research has found that using Twitter in the classroom can encourage students to engage with material in ways traditionally difficult in large lecture settings, such as sharing opinions, asking questions, and tying concepts to personal experience. The present research examines if specific types of content (e.g. reflecting, questioning, summarizing) in homework tweets affect student performance and participation in the class. Student tweets from a large lecture course were coded for content and tied to student exam and participation grades. While there was no one tweet content type consistently found to be associated with higher grades, all three types of content positively correlated with final grades. Students who tweeted with greater frequency also earned higher participation and final grades. Lastly, the data showed students' strong tendency towards tweeting reflectively, possibly illuminating affordances of the Twitter platform or a larger trend in learning.

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## Mobile Phones: Can Frequent Use Elicit Separation Anxiety, Social Support, or Both?

JILL C. LIEBERMAN

Under the supervision of Dr. Jeffrey T. Hancock  
Department of Communication

In today's day and age, people spend a great deal of time with their mobile phones. Is it possible for individuals to form an attachment to their device, thus creating separation anxiety when removed from their phone? Or, does the phone's innate features of connection to family, friends, and loved ones prime users to perceive their social support as larger when holding their phone? To test these questions, the present study asked participants to rate how painful an upcoming flu shot would be after either having their phone taken away or being instructed to hold their phone. The data revealed that there was no evidence of separation anxiety in the pain scores after having one's phone taken away, but there was some evidence that simply holding one's phone reduced perceptions of anticipated pain, suggesting that phones can prime increased social support. This research enhances our understanding of how mobile phones can act as attachment objects.

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## Dual Screen Processing: How Do New Media Enhance the Traditional Television-Watching Experience?

JAIMEE L. PAVIA

Under the supervision of Dr. Jeffrey T. Hancock  
Department of Communication

Digital media and traditional forms of media are integrating in ways that alter how audiences consume information and interact with one another. With a focus on dual screen processing, this honors thesis set out to discover whether engaging with digital media technology while watching television leads to increased engagement in programming, or serves as a distraction from program content. Results demonstrated that dual screen processing is an important component of audiences' television watching experiences. Furthermore, over a third of the coded messages suggest that engaging in dual screening while watching TV enhances the experience of watching television for viewers, and that the medium of the dual screen (e.g., text messaging, facebook messaging, or twitter) can affect the content of messages shared on the second screen. Currently, television networks focus on connecting with audiences via Twitter. Based on findings in the study at hand, Facebook messaging and text messaging are the most common forms of digital media being used while people watch television, so networks should reframe their strategies regarding how to engage people in the content of programs through the simultaneous use of multiple forms of digital media.

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## Placing the Somali Refugee Crisis: An Incorporated Comparison of the Somali Refugees' Experience in Ethiopia and Kenya

SAMUEL M. RITHOLTZ

Under the supervision of Dr. Wendy Wolford  
Department of Development Sociology

Humanitarian responses to refugee crises focus solely on the emergency response to the basic needs of the refugees and as a result removes them from the political and socioeconomic contexts that produced their displacement. Refugees are then viewed as a group that is defined by their uprootedness and identified as an apolitical body. The research in this study works to "rehistoricize" Somali refugees by analyzing historical and contemporary documents to reconstruct the historical experiences of both refugee populations in Ethiopia and Kenya. This paper uses an incorporated comparison of the social, cultural and political situations of Somali refugees in Kenya and Ethiopia to establish three main reasons for their differential treatments and experiences. First, differing political methods of managing frontier states have created different histories with the native Somali population. Second, differing perceived identities of Somali refugees have resulted in contrasting state responses to incoming Somali refugee populations. And third, differing demographics of refugees within the camp and local populations surrounding the camps have incited conflict in Kenya's Dadaab camps, while maintaining peace in Ethiopia's Dollo Ado camps. Understanding

these states' relations with their refugee populations allows for more informed policy that can work to protect the livelihoods and rights of these refugees in the specific context of each country.

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## Formative Ideologies and Determinants of Change: Challenges to the Social and Political Paradigms of the Israeli State

RACHEL B. SCHLASS

Under the supervision of Dr. Wendy Wolford  
Department of Development Sociology

The security sector within Israel is closely bound to ruling elites and institutionalized power structures, and to seek to reform it is threatening to the established domestic order. Recent social protests attempted to destabilize these pre-existing structures and this paper provides a qualitative survey through which the significance of these challenges may be approached. I evaluated social actors of two mobilization efforts: the African Asylum Seeker movement, and the J-14 Social Protest movement through participant observation. In total 30 interviews were conducted, recorded and coded. Their responses illustrated an overwhelming and universal preservation of state-building values irrespective of obvious challenges to Israeli state sovereignty and whether or not their claims were native or immigrant driven. The state's adopted strategies to those claims reinforced existing political sovereignty of the security sector despite emergent challenges. The recent cycle of movements appear related in other ways as well. Symbols, location and territory are themes that reinforce the presence of nationalism despite mobilized patterns of contention among the heterogeneous Israeli landscape. Compared to previous claims when violence and repression established the loudest political voice within the defined territory of Israel a new opportunity structure was observed that is born out of desire to foster social justice among the changing population and population structures of Israel.

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## Election Cycle Effect on the Voting Behaviors of Tompkins County Legislators: A Qualitative and Quantitative Analysis

SAUL B. SCHUSTER

Under the supervision of Dr. John Sipple  
Department of Development Sociology

This study examined how the “run-up to the election” (Walter, 2008) affects the voting behaviors (frequency and unanimity on key substantive policy arenas) of elected officials in the Tompkins County Legislature. A statistical analysis was done on nine consecutive years of Legislative meeting agendas to track trends in the substantive nature of the resolutions voted upon. Additionally, eight structured interviews were conducted with Tompkins County's elected officials who were recruited by their official email addresses posted on the Tompkins County Legislature website. Based on this interview data, resolutions were coded into five categories: Symbolic, Administrative, Fiscal, Grant, and Building. The findings suggest that resolutions “in line with public sentiments” were more likely

to occur in election years- as defined by county Legislators. These findings support previous research, which has found that opportunistic policy making happens in the lead up to election cycles.

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## Bridging the Digital Divide: Access and Use of Internet and Mobile Technology for Health Information among Hopi Indians

JANA WILBRICHT

Under the supervision of Dr. Angela Gonzales  
Department of Development Sociology

American Indians living on rural Indian reservations experience significant health disparities and a lack of infrastructure, which hinders access to health information. Understanding the availability and use of online/mobile health information among American Indians is important for identifying how the technology may improve access to health information. To learn about the current use of online/mobile health information and barriers to access, I collected focus group and interview data among members of the Hopi Tribe, a rural reservation community in Arizona. My findings suggest that while the digital divide continues to limit access to the Internet, the use of mobile technologies is increasing. Major concerns regarding online/mobile health information were uncertainty about effective use and a perceived culture-technology dichotomy. These concerns can be addressed through community education and the development of culturally relevant content. The data highlights the potential of online/mobile health information to reduce health inequality in American Indian communities.

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