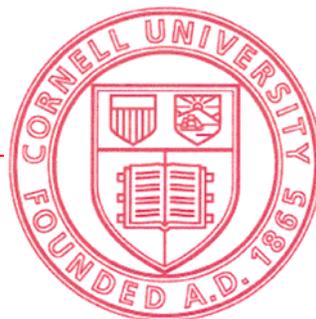


College of Agriculture and Life Sciences

2011—2012

Research Honors Program Abstracts



The College of Agriculture and Life Sciences is considered the best college of its kind in the nation, if not the world. Our mission is to discover, integrate, disseminate, and apply knowledge about agriculture and food sciences, applied social sciences, environmental sciences and the life sciences as a basis for sustainable improvement in the lives of people throughout New York State, the nation, and 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 2011-2012 honors thesis projects described in this booklet demonstrate an impressive capacity for personal dedication, mature scholarship and intellectual growth. The original research contained in this booklet examines some of the most pressing and relevant questions of our time.

Many students consider the research they undertake as undergraduates in CALS to be the most challenging, enduring, and valuable experiences of their time at Cornell. As a faculty member, I have witnessed this first-hand with my own advisees. As dean, I will continue to foster the college's unwavering commitment to undergraduate research.

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 can see from reading the following abstracts, these new graduates will soon take their place among tomorrow's thought leaders.

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

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Predicting Health Issues in Holstein Heifer Calves

CHELSEA A. BELLMUND

Under the supervision of Dr. Debbie J. Cherney and Keenan C. McRoberts
Department of Animal Science

The aim of this study was to evaluate the usefulness of early-life health assessment mechanisms using non-invasive infrared thermometry and milk replacer intake in Holstein heifer calves within the first month of life. Early prediction of illness including bovine viral diarrhea virus (BVDV) and bovine respiratory disease (BRD) can allow for more effective treatment. Holstein heifer calves (n=49) were selected at birth from Cornell University's Teaching and Research Dairy Center, and individual calves were in the study from April 28, 2011 - July 30, 2011. Surface temperatures were recorded using a Fluke™561 handheld infrared thermometer at three locations: cheek, ribs, and rump. Calves were housed in three locations: maternity unit, group greenhouse, and individual hutches. Milk replacer intake and drinking speed (Advance™ Excelerate™ KwikMix™) were obtained using a De Laval CF1000™ automatic feeder. Statistical analysis was undertaken to: 1) predict illness rate based on birth day parameters including surface and core temperatures during the first 24 hours of life, and, 2) diagnose daily illness status and severity using infrared thermometry and milk replacer consumption. Several variables significantly predicted disease status: drinking speed, milk replacer consumption, observation date, core temperature, cheek surface temperature, rib surface temperature, rump surface temperature, air temperature, relative humidity, location and activity. Univariate models were generated to test mean differences. Infrared thermometry and milk replacer consumption can be used to predict and assess early life illness status. However, accuracy may be too low for implementation as a practical management tool.

Comparison of Potassium (K) Soil Tests

YIKE BING

Under the supervision of Dr. Quirine M. Ketterings
Department of Animal Science

Potassium (K) is required in large quantities for important field crops like alfalfa. Fertilizer recommendations for K are typically based on soil test K or K saturation ratios derived from the Morgan, Modified Morgan, or Mehlich-3 agronomic soil test. In addition, the SrCl₂ extraction has been evaluated. Cornell University has developed K recommendations based on the sufficiency approach and the Cornell Morgan test. The objective of this study was to evaluate if results from three other agronomic soil K tests and K saturation ratios derived from these soil tests (Modified Morgan, Mehlich-3, and SrCl₂ agronomic soil tests) can be used to derive Cornell Morgan soil test K results. In total, 488 soil samples were collected from six regions in the state in spring and fall 2010, including three soil management groups. All samples were analyzed for Morgan, Modified Morgan, Mehlich-3, and SrCl₂ extractable K. Potassium saturation ratios were determined as $K/(K+Ca+Mg)$. A linear regression model was used to compare Morgan soil test K with other soil test K and K

saturation ratios. The study shows a strong linear relationship among the three soil tests K levels and the Morgan soil test K results. However, the K saturation ratios were poorly correlated with Morgan soil test K. Data obtained in spring and fall resulted in similar relationships. The results suggest a possibility to convert the three soil test K data to Morgan equivalents only. Further field testing is needed to determine which soil test most accurately predicts K fertilizer needs

Canine Laryngeal Paralysis as a Sign of a Diffuse Neuropathy in Older Affected Dogs

LAUREN C. BOOKBINDER

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

Idiopathic laryngeal paralysis (LP) is a disease that often affects older, large breed dogs such as Labrador Retrievers. While there are several known etiologies of LP, the form of the disease that affects these older dogs is currently considered idiopathic, or acquired. Recently literature suggests that dogs affected by idiopathic LP are actually affected by a more diffuse neuropathy, causing LP, esophageal issues and hind limb neurologic signs. Two distinct types of LP causing polyneuropathy complexes have been defined in certain populations of young puppies with LP. It has been suggested that one of these also affects older “idiopathic” dogs, but over a longer timeline, with less severe symptoms than seen in affected young puppies.

Cases of idiopathic LP from 2007-2012 seen at Cornell University Animal Hospital and Upstate Veterinary Surgical Center were analyzed in effort to determine how common signs of a diffuse neuropathy, including hind limb neurologic signs and esophageal abnormalities are seen in dogs affected by idiopathic LP. Survival and complication rates were analyzed based on whether or not dogs exhibited neurologic co-morbidities. Survival analyses showed that dogs with neurologic co-morbidities were more likely to be alive at follow-up compared to those without these co-morbidities. Similarly, results showed that dogs with neurologic co-morbidities were more likely to suffer from chronic complications compared to dogs without these signs. The results of this study indicate the relative for thorough neurologic evaluations of dogs presenting with idiopathic LP.

Effects of Sex and Scotorefractory State on Obesity Induced by Photostimulation in Siberian Hamsters (*Phodopus sungorus*)

SARAH E. CUDNEY

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

The rising prevalence of obesity is associated with an increasing incidence of heart disease, diabetes and other health risks. In addition, severe cases of obesity are associated with an even greater risk of morbidity and mortality. Therefore, animal models of morbid obesity are required to better elucidate the underlying mechanisms. Our investigations in the Siberian hamster (*Phodopus sungorus*) suggest

that pronounced obesity can be reliably induced in this species without relying on genetic manipulation or overly fatty and palatable foods. In a prior study on reproductive aging in female Siberian hamsters, we incidentally observed marked obesity in a group of hamsters that were exposed to a particular photoperiodic regime. In short day (SD) lengths, Siberian hamsters inhibit their reproductive physiology and reduce food intake and body mass. However, hamsters become refractory to SD after 15-20 weeks and revert to the long day (LD) phenotype. In the previous study, refractory animals appeared to be particularly sensitive to photostimulation (transfer to LD), in terms of increasing body mass. To test the hypothesis that refractoriness to SD predisposes hamsters to severe obesity, we photostimulated females and males in different states of SD responsiveness (inhibited or refractory). We determined that photostimulation during the SD-refractory state is particularly effective in inducing pronounced obesity and leptin resistance in female hamsters. We propose that this experimental framework is a useful model to investigate the factors and signals that create a predisposition to excessive food intake and body mass, without having to rely on genetic or dietary manipulations.

Seasonal Dietary Transition in Birds

SEAN W. DONEGAN

Under the supervision of Dr. David N. Bonter and Dr. John I. Lovette
Cornell Lab of Ornithology

During the course of the winter season, birds increase their body fat in response to environmental signals. Previous research has suggested that a dietary shift towards higher intake of food or a shift towards food sources with a higher fat content in response to declining ambient temperature occurs to supply this demand. We hypothesize that non-migratory bird species will prefer food options with a higher fat content as the temperature decreases in order to raise their body fat content over time. We tested whether this relationship between dietary shift and temperature exists. Forty-five passerine birds from six different species were captured in mist nets, tagged with a radio frequency identification (RFID) antenna designed to read passive integrated transponders (PIT Tags) and released into the wild. Over the course of the study, these birds were offered two food types that differed in fat content. The study was carried out from mid-autumn to late winter, during which the ambient temperature was recorded and compared to the visitation rate of these birds to the two food sources. The visitation rate of birds at each specific temperature showed an increased consumption of both food sources as ambient temperature decreased. There was no shift in dietary preference for the food option that offered a higher fat content. Data indicate a hyperphagic response to decreasing temperature and a continuous preference for a mixed diet that held true for six passerine bird species in their natural habitat.

Genetic Profile of Non-esterified Fatty Acids (NEFA) and β -hydroxybutyrate (BHBA) Concentrations during the Transition Period, Disease Development, and Milk Production in Dairy Cattle in the Northeast USA

ARIEL J. GARLAND

Under the supervision of Dr. Paula A. Ospina
Department of Animal Science

The genetic profiles of metabolic traits in the transition period have not been fully evaluated. Objectives of the study were to evaluate the genetic profile of: 1) NEFA and BHBA levels during the transition period, 2) the development of periparturient diseases 3) milk and 4) body condition score (**BCS**) in 100 free-stall, total mixed ration fed herds throughout the Northeast. Approximately 30 animals per herd were sampled cross-sectionally, BCS was assigned at time of blood collection, and disease information was collected within 30 days in milk (**DIM**). Milk was recorded at 120 DIM using 305 mature equivalent data. To be included in the genetic analysis: sire, dam, and maternal grandsire were identified using dairy software and National Association of Animal Breeders sire database information. Data were analyzed with an animal model; cow was fitted as a random effect including pedigree information to account for genetic relationships between animals. In total 2,728 cows from 889 sires were included in the genetic analysis. Heritability was estimated using residual maximum likelihood estimates of (co)variance and were: 0.23 for BCS; 0.04 for NEFA; 0.0 for BHBA; 0.12 for displaced abomasum (**DA**); 0.11 for clinical ketosis (**CK**); and 0.18 for milk. When the population was limited to sires that had at least 2 daughters (1,000 cows and 171 sires), heritability estimates were: 0.18 for BCS; 0.01 for NEFA; 0.03 for BHBA; 0.24 for DA; 0.25 for CK; and 0.16 for milk. Further investigation with more daughters/sire is warranted to evaluate the heritability of metabolic parameters.

Phosphorus Management Strategies and Their Impact on Manure and Fertilizer Management in New York State

JULIA S. KNIGHT

Under the supervision of Dr. Quirine M. Ketterings
Department of Animal Science

Loss of phosphorus (P) from agricultural fields can contribute to eutrophication of surface water along with contamination of groundwater. Thus, management tools and policies are needed to reduce the risk of P enrichment of surface waters. In response to the Chesapeake Bay Protection and Restoration Executive Order issued by President Obama in May 2009, the United States Environmental Protection Agency (USEPA) introduced a P-saturation (P_{sat}) management strategy (for federal land) which is solely based on soil test levels while the currently implemented P index approach uses soil tests along with the risk of P loss (transport) from the field. This move highlights the USEPA's view that the P index approach is insufficient. Such a change to a soil test based cut-off to land application of manure and fertilizer may have tremendous impacts on farming operations within the Chesapeake Bay Watershed and across the United States. The USEPA does not recommend any one methodology for determining P_{sat} nor do they explain their 20% P_{sat} cutoff. In this project we aimed to (1) compare the impact of use of different P management strategies and cutoffs (P index versus soil test P and P_{sat} approaches) on P application restrictions; and (2) document variability in Fe, Al, and Ca (used to determine P_{sat}) between laboratories and soil test chemistries (Morgan and Mehlich-3). Results showed P_{sat} increased manure application bans to

fields by 5% over the current P index approach for the fields in this study and that implementation of a Psat approach will cause restrictions on P application for fields with a low P index transport risk.

Nitrogen Dynamics of Cover Crops in Corn Rotations in New York State

EMMALINE A. LONG

Under the supervision of Dr. Quirine M. Ketterings
Department of Animal Science

Cover crops are increasingly incorporated into crop rotations of dairy and grain farms in New York (NY) to reduce erosion and nitrate leaching loss, increase soil organic carbon (C), and supply nitrogen (N) for following crops. Research is needed to quantify N availability from cover crops, resulting in economic and environmental benefits. Four studies were conducted: (1) a survey of 115 NY dairy farmers regarding cover crop practices, motivations of use and research needs, (2) a 13-week soil incubation study with five plant materials, (3) a field study at two sites in western NY with plots of different cover crops (4) a field study in western NY with triticale planted as a double crop harvested for forage. Studies 2-4 were conducted to determine the effect of C:N ratio and total biomass on N release dynamics over the growing season. The survey showed cover crops were grown primarily for soil conservation and organic matter accumulation. Most commonly grown was winter/cereal rye. Results of the incubation study showed that cover crop C:N ratio determines whether nitrate is immobilized or released; the greatest N release peak occurs with incorporation of the lowest C:N material. The field studies showed large accumulation of C and N for oats seeded after a small grain in the rotation but further research is needed to determine spring N loss as oats winterkill in NY. Triticale added to total yield without impacting yield of the corn following the triticale double crop and could be considered a suitable double crop.

Neonatal Programming: The Lactocrine Hypothesis and the Administration of Oral Exogenous Insulin in Dairy Calves

DANIEL J. LOPEZ

Under the supervision of Dr. Michael E. Van Amburgh
Department of Animal Science

Increasing pre-weaning nutrient intake in dairy calves result in greater daily growth rates and this has been shown to increase future milk production during the first three lactations. Thus, early life nutrient supply appears to program the calf for enhanced milk yield. Colostrum, or an animal's first milk, is rich in both nutrients and growth factors. The hypothesis is that these growth factors can program an animal's growth and development if received during an early critical period. Previous studies have demonstrated that varying only the first feeding of colostrum can have long-term effects in both pre-weaning and pre-pubertal growth rates. One potential candidate for altering energy metabolism is insulin. Newborn calves (n=6 per treatment; balanced for sex of calf) received colostrum replacer either with or without 1,000 units of insulin and blood samples were taken every

30 min for the first 4 hours to measure plasma insulin and glucose concentrations. Calves provided colostrum replacer supplemented with insulin had significantly higher concentrations of plasma insulin ($p = 0.01$) and plasma glucose ($p = 0.02$) compared to calves fed colostrum replacer alone. The data suggest that insulin is capable of driving glucose uptake through the neonatal gastrointestinal tract. This is consistent with previous studies demonstrating that colostrum provided prolonged increases in glucose status in calves. It is therefore thought that insulin is a milk-borne morphoregulatory factor that has the potential to program long-term glucose metabolism in neonatal calves.

The Effects of Concentration and Temperature on the Inactivation of *Ascaris suum* Eggs by Butanoic Acid

VALERIE C. MARCANO

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

Human ascariasis is caused by the nematode *Ascaris lumbricoides*. The adult female passes unembryonated eggs in the infected individual's feces, frequently contaminating drinking water sources and soil. Sewage sludge and wastewater are often used as fertilizer and for irrigation, especially in developing countries. *Ascaris* is a model organism for developing environmentally safe disinfection methods due to its high resistance. Previous research in our laboratory has stimulated interest in short chain fatty acids (SCFA) as a method for killing *Ascaris* eggs. The aim of my project is to evaluate the use of SCFA, specifically butanoic acid, to kill *Ascaris* eggs. Purified *Ascaris* eggs were exposed to different molarities of butanoic acid, including 1.36M, 1.0M and 0.5M, at temperatures of 4, 22, 37, 45 and 60°C for different periods of time. At higher temperatures eggs were inactivated faster, and lower concentrations of butanoic acid were less effective than higher ones. At 4°C, 80% of eggs were viable after 24 hours in 1.36M butanoic acid (pH 4.0). At 22°C (1.36M butanoic, pH 4.0, 6 hours) the eggs were 100% inactivated. At 37°C (1.36M butanoic acid, pH 4.0) the eggs were 100% inactivated in 30 minutes. At 45°C eggs were 100% inactivated after 20 minutes when exposed to 1.36M butanoic acid and when incubated at 60°C in the presence or absence of butanoic acid they were 100% inactivated in 10 minutes. Our future experiments will examine similar concentrations and temperatures but will use human/animal sludge or soil as the matrix rather than water.

The Effects of CpG Oligodeoxynucleotides on the Course of *C. parvum* Infection in the Bovine Neonate

BRIANNA J. POMEROY

Under the supervision of Dr. Jerrie Gavalchin and Dr. Daryl V. Nydam
Department of Animal Science / Department of Population Medicine

Cryptosporidium parvum is an infectious, zoonotic parasite that is highly prevalent throughout United States dairy operations. The parasite infects epithelial cells of the small intestine and

symptoms are watery, severe diarrhea. CpG oligodeoxynucleotides (ODNs) are motifs found in bacterial and viral DNA that stimulate immune responses, and a previous study reported decreased oocysts in the intestine as well as a decrease in clinical symptoms in *C. parvum*-infected mice treated with CpG ODN. However, other studies have found that CpG treatment had adverse effects on the course of infection. Here we explored the effect of CpG ODN treatment, at 50µg or 200µg, on the course of *C. parvum* infection in male Holstein calves. We found that CpG ODN administered intramuscularly, prior to and immediately following infection with *C. parvum*, resulted in a trend towards increased proliferation of PBMs to T cell mitogens but decreased proliferation to *C. parvum* oocyst antigen. The production of *C. parvum*-specific IgM was decreased by treatment, and there was a trend towards an increase in the total number of oocysts shed in feces, although none of these responses reached statistical significance. There was no effect on the day of onset of oocyst shedding or production of *C. parvum*-specific IgG. The results of this study suggest that the effects of CpG administration on the course of *C. parvum* infection is complex, and must be further investigated to determine whether this treatment will enhance protective immune function or lead to immunosuppression and negatively impact the course of disease.

Gene Expression Monitoring of Mast Cell Activity in Connection with Equine Laminitis

CARLA L. STOFFEL

Under the supervision of Dr. Samantha A. Brooks
Department of Animal Science

Equine laminitis is a disease of the hoof characterized by inflammation of the laminae, the connective tissue between the coffin bone and the hoof wall. It has been suggested that laminitis can lead to a local and/or systemic inflammatory response, involving the release of vasoactive amines into the blood stream and surrounding tissue.

The release of these mediators is characterized by the degranulation of mast cells (MCs). In this study, it was hypothesized that the relative expression of two MC-related genes, mast cell growth factor receptor (*KIT*) and mast cell tryptase (*MTC*), reflects the presence and severity of inflammation, and can be used to facilitate early detection and treatment of laminitis.

The objectives of this study were 1) to determine where, within the hoof, MCs may reside, 2) to investigate MC activation, following different forms of laminitis, and 3) to determine the time-course of MC activation, following the onset of inflammation. I compared *KIT* and *MTC* expression between hoof sections of control horses and of horses with different conditions of laminitis. I also compared *KIT* and *MTC* expression in a time-course study using cell culture following *in vitro* stimulation.

The results of our study indicated that MC abundance and activity decreased distally from the coronary band to the toe of the laminae. Affected laminar tissues contained less *KIT* and *MTC* expressing MCs than control tissues. MC activity may have occurred systemically, or the MCs may have degranulated at the onset of disease, prior to collection of our samples.

Nitrogen Dynamics Following Surface-Application of Enhanced Efficiency Fertilizers

JEFFREY K. WILLIARD

Under the supervision of Dr. Quirine M. Ketterings
Department of Animal Science

Nitrogen (N) is required in large quantities for important field crops like corn (*Zea mays* L.). Nitrogen fertilizer efficiency can be increased if N loss can be reduced. Urease inhibitors, nitrification inhibitors, and slow and/or controlled release fertilizers are all enhanced efficiency fertilizers (EEFs) designed to reduce ammonia volatilization, nitrate leaching, and/or denitrification.

My objectives were to study the impact of the surface application of enhanced efficiency fertilizers on ammonia volatilization, ammonium accumulation, and nitrate release over time and to determine the short-term effects of these fertilizers on the Illinois Soil Nitrogen Test as an effective tool in identifying soil nitrogen supply.

An incubation study was conducted to compare ammonia-N, ammonium-N and nitrate-N dynamics following surface application of urea, Agrotain® (urease inhibitor), SuperU® (urease/nitrification inhibitor), NutriSphere-N® (urease/nitrification inhibitor), and ESN® (urea controlled release polymer) and to evaluate the impact of ammonium-release on the Illinois soil nitrogen test (ISNT)-N as a tool for the assessment of soil organic N supply potential.

This study showed Agrotain®, SuperU® and ESN® to be effective in reducing N loss. Ammonium-N and ISNT-N showed a linear correlation indicated that sampling for soil organic N supply should be done prior to application of unamended urea, NutriSphere-N®, Agrotain Ultra® and Super U® while sampling can occur within the first 8 wk after application of ESN® (ideally within 2 wk) but should be avoided later in the growing season.

I feel that the data collected in this study will be beneficial in reducing nitrogen loss to the environment and increasing the efficiency of nitrogen fertilizers applied.

Plasma Adiponectin Level During the Transition from Late Pregnancy to Early Lactation in Dairy Cows

BO HYUNG K. YOON

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

Dairy cows develop insulin resistance during the transition from late pregnancy (LP) to early lactation (EL). The mechanisms accounting for this phenomenon are poorly understood. The adipocyte-derived hormone adiponectin has been shown to improve insulin sensitivity in mice and

humans. In these species, adiponectin production is stimulated by the insulin sensitizer 2, 4-thiazolidinedione (TZD). Moreover, it circulates as 3 isoforms: a high molecular weight form of >540 kDa consisting of 18-30 adiponectin monomers, a medium molecular weight form of 180 kDa consisting of 6 monomers and a low molecular weight form of 90 kDa consisting of 3 monomers. To determine if adiponectin could contribute to the induction of insulin resistance in dairy cows, plasma adiponectin was measured in LP and EL in 10 dairy cows. Plasma adiponectin dropped by 38% from LP to EL. This reduction in plasma adiponectin was not accounted by a change in adiponectin mRNA in adipose tissue. Next, the molecular forms present in plasma were evaluated by gel filtration chromatography. In both LP and EL plasma, adiponectin appeared only as a high molecular weight form. Finally, dairy cows in LP were administered TZD or saline solution (n = 7 per treatment) for 14 days. TZD did not increase plasma adiponectin relative to control. In summary, plasma adiponectin is reduced in dairy cows during the transition from LP to EL and this reduction could contribute to the induction of insulin resistance in EL. Moreover, bovine adiponectin circulates in a single molecular form that is unresponsive to TZD.

Insights into Nuclear Localization of C1-Tetrahydrofolate Synthase in Mouse Liver and HeLa Cells

OLUFUNMILAYO C. AGUNLOYE

Under the supervision of Dr. Patrick J. Stover and Dr. Martha S. Field
Division of Nutritional Sciences

The enzyme C1-Tetrahydrofolate Synthase (C1-THF Synthase) is the product of the *Mthfd1* gene. There are two mammalian isoforms of this enzyme, *Mthfd1* and *Mthfd2*; *Mthfd1* encodes the cytoplasmic isozyme and *Mthfd2* the mitochondrial isozyme. MTHFD1 generates 5,10-methylene tetrahydrofolate for the synthesis of thymidylate, and methionine. Recently, our laboratory has shown that *Mthfd1* is associated with other folate-dependent enzymes of the *de novo* thymidylate synthesis complex in the nucleus at the replication fork, and that in folate deficient conditions 5,10-methylene tetrahydrofolate is made available for thymidylate synthesis. Using the *Mthfd1*^{gt/+} murine model, we studied the long-term metabolic alterations in the liver to see if these trends model the colon. Additionally, HeLa cells were used to study the nuclear mechanism of action of C1-THF Synthase. C1-THF Synthase is shown to localize to the nucleus, and its nuclear levels increase during folate deficiency in murine liver. The *Mthfd1*^{+/-} genotype is protective against uracil misincorporation in liver nuclear DNA during folate deficiency. The *Mthfd1*^{+/-} genotype is also associated with elevated plasma formate, and unlike other folate-dependent enzymes that localize to the nucleus; the nuclear localization of C1-THF Synthase is not regulated by conjugation with the Small Ubiquitin-Like Modifier (SUMO) protein. Further investigation of the mechanistic role of C1-THF Synthase in *de novo* thymidylate and purine synthesis and in regulation of folate metabolism is essential, particularly in light of findings that *Mthfd1* knockdown mice are homozygous lethal and that gene polymorphisms in *Mthfd1* have a strong association with increased risk of NTDs in pregnancy.

Rats Do Not Engage their Cholinergic Systems for Near Threshold Odor Detection

SAMUEL ALPERIN

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

Acetylcholine is an important neuromodulator in the olfactory bulb for learning and memory processes. Additionally, noradrenaline has been shown to be engaged at near threshold odor levels to promote discrimination and detection of odors (Escanilla, submitted). The aim of this study was to explore the possibility of the cholinergic system also being involved in the detection of odorants at near threshold levels. Consistent with previous studies, we found that rats are able to detect odors at lower thresholds when they are motivated by a reward. We first showed that infusion of a cholinergic agonist (carbachol) has the previously-found cholinergic effect of increasing olfactory discrimination between similar odorants (Chaudhury et al., 2009). However, we next showed that infusion of carbachol did not decrease the detection levels. Moreover, in the reward-motivated

discrimination paradigm, we found that rats were still able to detect at lower thresholds when infused with cholinergic antagonists (methyllycaconitine citrate hydrate and scopolamine). These results suggest that the cholinergic system is not engaged by rats in the detection of near threshold odorants.

Controlling Neurogenesis: The Role of *Jagged1* and *wnt* Signaling on Neural Stem Cells Maintenance and Proliferation

ALESSANDRO A. BAILETTI SAEZ

Under the supervision of Dr. David M. Lin
Department of Biomedical Sciences

During embryonic neurogenesis, neuronal stem cells give rise to neuronal progenitor cells which then divide and produce neuronal subtypes. In the late mouse embryo, neurogenesis begins to be restricted to the dentate gyrus in the hippocampus and the subventricular zone (SVZ) [1]. This process is highly regulated by different pathways. The *Notch* pathway is critical for maintaining neuronal stem cells population, while the *wnt* pathway up regulates neurogenesis [2,3]. However, what activates the *Notch* pathway and what mediates the neurogenic effect of the *wnt* pathway is still unknown. In colorectal cancer cells, studies have shown that *wnt* regulates stem cell properties by regulating *Notch* signaling through *Jagged1* expression [4,5]. *Jagged1* is a *Notch* ligand and it is expressed in the SVZ lining. This suggests *Jagged1* activates *Notch* signaling and may mediate *wnt* signaling in the SVZ. This model was tested using *in vivo* and *in vitro* experiments. *In vivo*, *Jagged1* mutants show smaller brain structures by Hematoxylin and Eosin staining and more importantly decrease gene expression on q-PCR analysis. *In vitro*, this study shows that *Jagged1* mutants form smaller neurospheres and *Jagged1* is up regulated when *wnt* signaling is over expressed. These results show that *Jagged1* regulates neurogenesis in the SVZ by mediating the *Notch* and *wnt* pathways.

Inbreeding and Potential for Evolutionary Rescue after Environmental Change

KATHRYN E. BLACKLEY

Under the supervision of Dr. Nelson G. Hairston, Jr.
Department of Ecology and Evolutionary Biology

Evolutionary rescue occurs when populations that experience a severe decline in numbers following environmental change adapt evolutionarily and so avoid extinction. However, low population size, even without extinction, can have detrimental effects such as inbreeding depression that may influence the likelihood of evolutionary rescue. The aim of this study was to determine the effect of inbreeding on the propensity for evolutionary rescue. The monogonont rotifer *Brachionus plicatilis* was used as the study species and environmental change was created by increasing the salinity of its medium. All rotifers used in my study were originally derived from a laboratory stock culture that had been previously forced to a population genetic bottleneck with some lineages then maintained clonally while others were induced to sexual reproduction which led to inbreeding. Populations were

later subjected to the environmental change and their resulting mortality and growth during recovery were observed. Inbreeding was found to significantly decrease the ability of the populations to recover from the environmental stress.

“Implications of Landmark Analysis of Oligocene Camelid Endocranial Casts for Phylogeny and Brain Evolution”

SERINA S. BRADY

Under the supervision of Dr. Warren D. Allmon
Department of Earth and Atmospheric Sciences

Recent phylogenetic hypotheses seem reluctant to use endocranial cast data in their analyses. This includes the Camelidae phylogeny. In this study, I describe and compare the morphological characters of the endocranial casts of various camelid radiations, review, and add new data to the current camelid phylogeny based on these findings. To determine what features of the brain could be studied with confidence, I first created a silicone endocast of a living member, the alpaca (*Lama pacos*) and performed a detailed comparison with the brain dissected from the same individual. Once I identified the features that preserve in endocranial casts, I then measured those on various camelid species in which endocasts are known. After this landmark analysis, I created a character matrix using these visible features and subsequently mapped onto the existing camelid phylogeny, originally based on metatarsals and skulls by Janis et al (1998). Comparisons of endocranial casts of species from the Camelidae reveal interesting evolutionary trends linked to behavioral and ecological changes. These changes include prominence of the optic nerve, overall brain shape and size, as well as an increase in the height of the neocortex. Endocranial characters support recently published camelid phylogenetic hypotheses and I therefore conclude that endocranial casts can be used to study brain evolution in this family. This is the first time endocranial cast and brain characters have been applied to the camelid phylogeny.

Estimating the Effective Population Size of *Crassostrea virginica*

ASHLEY E. BROWN

Under the supervision of Dr. Matthew P. Hare
Department of Natural Resources

Effective population size (N_e) is an important parameter used to estimate the magnitude of genetic drift, a major evolutionary force, that a population experiences. Across many taxa N_e is one tenth smaller on average than the census population size because of overlapping generations, uneven sex ratios, and other demographic factors that increase the variance in reproductive success. Organisms that experience high fecundity, external fertilization, and larval dispersal, like the eastern oyster (*Crassostrea virginica*), are hypothesized to experience “sweepstakes reproduction”, or a high stochastic variance in reproductive success among individuals, resulting in a much lower N_e relative to N_{census} . Here the objective was to further test the sweepstakes hypothesis by estimating N_e in

oyster populations using two distinct, direct measures. Temporal samples of *C. virginica* from two eastern Florida localities were genotyped for nine microsatellite loci to estimate N_e . Effective population size was estimated using two methods, a two sample moments-based temporal estimation and a single sample linkage disequilibrium estimation. Results from both methods are consistent with N_e between 500 and 10,000. These values are similar to past studies indicating a sweepstakes reproduction hypothesis, although not as extreme of a sweepstakes reproduction as some past work has suggested. However, predicted differences for allelic diversity and N_e were not detected between cohorts of spat (early juveniles) and local adults, preventing a strong conclusion that *C. virginica* is in fact experiencing sweepstakes reproduction based upon the tested indicators in this study.

Deletion Mapping in a Binucleate System, Constructing a Physical Map of the *Tetrahymena thermophila* Genome

FRANCES L. CHEN

Under the supervision of Dr. Donna M. Cassidy-Hanley and Dr. Theodore G. Clark
Department of Microbiology and Immunology

The ciliated protozoan *Tetrahymena thermophila* has two separate nuclei: a diploid germline (micronuclear) nucleus that undergoes normal Mendelian transmission, and a polyploid somatic (macronuclear) nucleus that divides by non-Mendelian binary fission. Site-specific fragmentation of the five micronuclear chromosomes at conserved 15 bp chromosome breakage sequences (Cbs) generates approximately 225 macronuclear chromosomes. The nuclear dimorphism inherent in the *Tetrahymena* genetic system uniquely facilitates deletion mapping. This project uses a set of 151 micronuclear deletion strains to create a relational map linking the micronuclear genome to macronuclear chromosomes. Using sub-telomeric macronuclear sequences flanking micronucleus-specific Cbs sites as primers, we have mapped 89 Cbs sites to 45 deletions arrayed across three of the micronuclear chromosomes. In addition to defining existing deletions, this study also complements and confirms the genetic mapping performed in the laboratory of Dr. Eduardo Orias (UC Santa Barbara). We have used the results from this collaborative effort to construct relational maps arraying Cbs sites along chromosome arms for micronuclear chromosomes 1, 2, and 5. In addition, by further defining the physical extent of many of the deletions studied, this work facilitates the use of deletions in genetic screens and forward genetic analyses, enhancing the use of genetic approaches in *T. thermophila*, and adding to the versatility and usefulness of this model organism.

Morphological Correlates of Signal Development in Weakly Electric Mormyrid Fish

CATHERINE J. CHENG

Under the supervision of Dr. Carl D. Hopkins
Department of Neurobiology and Behavior

Weakly electric fish have evolved diverse electric organ discharges (EODs) that are used in electrolocation, sex- and species recognition, and other behaviors. The electric organs of mormyrids, a family of weakly electric African fish, are derived from muscle tissue. Two distinct electric organs exist early in development: the larval electric organ (LEO) and the adult electric organ (AEO). The ontogeny of the adult electric organ is not well understood, especially the development of the penetrating stalk system in each electrocyte. Using histological techniques and digital reconstructions of the AEO, we created a timeline of the morphological correlates of the developing EOD in *Brienomyrus brachyistius* larvae and juveniles (6 – 45 mm). The LEO is active first, generating a monophasic EOD before the AEO becomes functional. The AEO first appears in 8-9 mm fish, arranged myomerically in the deep lateral muscle of the caudal peduncle. The stalk system arises from a single stalk on the posterior electrocyte face at this stage, increasing in number but not in thickness until the AEO becomes active in 14 – 18 mm fish. The formation of penetrations occurs in 18 – 20 mm fish, beginning near the first branch point from the site of innervation as the stalk presses into the posterior electrocyte face without fusing, eventually passing through the electrocyte as a U-shaped penetration that generates an initial head-negative phase in the adult EOD. The stalk continues to emerge from the electrocyte until the majority of the stalk is found on the anterior face.

The Effect of Ribonucleotide Reductase Deregulation on Mitochondrial Function and Reactive Oxygen Species (ROS) Production

AARON J. COHEN

Under the supervision of Dr. Robert S. Weiss
Department of Biomedical Sciences

Ribonucleotide Reductase (RNR) catalyzes the rate-limiting step in *de novo* deoxyribonucleotide triphosphate (dNTP) synthesis and plays an essential role in maintaining genomic integrity. RNR is a heterotetramer consisting of two large R1 subunits, encoded by *Rrm1*, and two small R2 subunits, encoded by either *p53R2* or *Rrm2*. The R2 subunit contains a dinuclear iron center, which binds oxygen and produces a tyrosyl radical (Y177) that is essential for RNR function. Previous studies have linked R2 deregulation with genomic instability and mitochondrial diseases. Because the R2 subunit produces free radicals, we investigated the effects of *Rrm2* deregulation on ROS production. We demonstrated that *Rrm2* overexpressing cells have increased cellular ROS. To determine if the tyrosyl radical is the source of this ROS, we generated cells overexpressing *Rrm2*-Y177F, a mutant form that cannot produce the tyrosyl radical. Surprisingly, *Rrm2*-Y177F overexpressing cells still have increased ROS. We then suggested two possible models to explain this. First, the *Rrm2*-Y177F subunits can bind endogenous *Rrm1*, possibly leading to less functional RNR, disrupted dNTP pools, depleted mitochondrial DNA (mtDNA), and increased mitochondrial ROS. This is supported by observed mtDNA depletions and increased mitochondrial ROS in *Rrm2*-Y177F cells. Furthermore, cells overexpressing *Rrm2* mutants that cannot interact with *Rrm1* were generated. They do not exhibit mtDNA depletion but still have increased cellular ROS. This leads to our second model where the intact dinuclear iron center may contribute to increased ROS in *Rrm2*-Y177F cells. We are currently making *Rrm2* mutants that cannot coordinate iron to test this model. Since R2 deregulation has been implicated in cancer and mitochondrial diseases, our findings suggest a role of ROS and oxidative stress in these phenotypes.

The Effect of Temperature Change on Viral Pathogenesis of Viral Hemorrhagic Septicemia Virus (VHSV) in Fathead Minnow (*Pimephales promelas*)

REBECCA L. FELLMAN

Under the supervision of Dr. Paul R. Bowser
Department of Microbiology and Immunology

The prevalence of viral hemorrhagic septicemia virus (VHSV) among Great Lakes fish populations varies seasonally. Chronic infections affect neural tissue, while acute infections target other body organs, causing symptoms. Temperature variation also occurs seasonally, and can detrimentally affect fish immune systems, potentially affecting VHSV progression.

I investigated the effect of a 5°C temperature change on VHSV prevalence and severity in fathead minnow. Fish were exposed to VHSV genotype IVb and a temperature increase from 10°C to 15°C, decrease from 20°C to 15°C, or a stable temperature of 15°C. I evaluated prevalence of symptoms and death, tested for VHSV via cell culture of visceral tissue, and performed quantitative reverse transcription polymerase chain reaction (qRT-PCR) assays on brain and visceral tissue extracts.

Fish that experienced temperature decrease had greater VHSV prevalence than those that experienced increase, and more tested positive by qRT-PCR of brain tissue than those that experienced no change. Visceral samples from fish that experienced either temperature change contained greater quantities of the virus than those from fish that experienced stable temperature, while brain tissue samples contained similar amounts. Thus, the severity of chronic infections was not affected by temperature change, but the severity of acute infections was increased in fish that experienced any temperature change. These results suggest that fish that encounter temperature changes, especially decreases, of 5°C are at higher risk of contracting chronic infections and severe acute infections, helping to explain seasonal fish die-offs attributed to VHSV.

Characterization of the Intracellular Trafficking of *Chlamydia trachomatis* Elementary Bodies

EVA FRANZOVA

Under the supervision of Dr. Marci Scidmore
Department of Microbiology and Immunology

Chlamydia trachomatis is an intracellular pathogen that is able to survive and replicate within a membrane bound vacuole called an inclusion. Protein synthesis by *Chlamydia* during first 2 h post infection has been shown to be responsible for the modification of the chlamydial inclusion membrane resulting in subversion of the host cellular trafficking pathways and the trafficking of the inclusion to the peri-Golgi region of the cell. In the absence of early chlamydial protein synthesis, *Chlamydiae* are unable to form an inclusion, remain dispersed within the host cytosol, and are ultimately trafficked to the lysosome. In this study we have examined whether chloramphenicol

inhibited EBs traffic to the lysosome via the classical endocytic pathway by examining the colocalization of EBs with Rab5, 7, and 11 which are markers of the early endosome, late endosome, and recycling endosome, respectively. By examining the colocalization of chlamydial elementary bodies with these markers, we observed the sequential but delayed trafficking of EBs through Rab5 positive early endosome, Rab7 positive late endosome, and Lamp-3 positive lysosomes. Unexpectedly we also observed a small population of EBs that colocalized with the Rab11 positive recycling endosome. Collectively, these data suggest that Chlamydiae experience delayed trafficking through the endocytic pathway in conditions when Chlamydiae fail to actively modify their intracellular environment.

Investigations of the Source, Distribution, Expression and Physiological Function of Thiaminase I

ERIC R. L. GORDON

Under the supervision of Dr. Esther R. Angert
Department of Microbiology

Thiaminase I is a vitamin degrading enzyme produced by microorganisms and often found in certain metazoan animals that can cause thiamine deficiency in natural ecosystems. The physiological function of this enzyme is still unknown. We adapted a photometric assay for thiaminase I that measures the rate of disappearance of a colored co-substrate for use with a high throughput plate reader. Using this assay, we characterized the conditions that promote thiaminase I production in some thiaminase I producing microorganisms and gained evidence for and against hypotheses for various physiological functions. We also conducted surveys of diverse metazoan organisms known and not previously recognized to have thiaminase I activity and found thiaminase activity in organisms not previously known to have thiaminase activity. Research on the expression of thiaminase I has possible implications for cancer research and correction of mortality due to thiaminase-induced thiamine deficiency syndromes.

Do Honey Bees Use the Directional Information in Round Dances to Help Them Find Nearby Food Sources?

SEAN R. GRIFFIN

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

Throughout his studies of dance communication by the honey bee, Karl von Frisch described two discrete dances used to recruit nestmates to rich food sources: the round dance, which supposedly indicates the presence of food sources near the hive but provides no location information, and the waggle dance, which indicates the distances and directions of food sources more than 100 m from the hive. The view that round dances and waggle dances are distinct signals has recently been revised in light of the finding, by several groups of researchers, that distance and direction

information is encoded in dances for food sources as close as 10 m from the hive. It remains unclear, however, whether dance followers can use the rather noisy directional information in dances for nearby food sources. This study looked at the patterns of recruitment to nearby food sources and found that dance followers can perceive and use the directional information in the dances advertising these food sources. Directional bias was seen as close as 10 m from the hive. Controls for release of assembly pheromone and for bee presence at the feeders indicate that these factors played a minimal role in producing the observed patterns of directional recruitment

Selective Advantage for Unpreferred Codons in *Drosophila melanogaster* Genes

CLAIR HAN

Under the supervision of Dr. Charles F. Aquadro
Department of Molecular Biology and Genetics

Drosophila's codon usage is biased to codons that end in G and C over those that end in A and T. Unlike the *Notch* gene of *D. sechellia* and *D. simulans*, *D. melanogaster's* *Notch* gene was previously identified to show an accumulation of A and T at the third codon position in amino acid-encoding sites but not in introns. 100 candidate genes that showed such differences between base pair substitution at synonymous sites and at introns were previously identified by the Aquadro lab through pair-wise analyses. To ensure that no deleterious polymorphisms were included, the previous analyses were repeated for the 100 genes with only fixed differences in *D. melanogaster*. Analyses considering only fixed differences supported the previous pair-wise result that the majority of the 100 genes showed positive selection for GC to AT changes at synonymous sites but not for AT to GC changes. The quantities of *Notch* mRNA and protein were then compared between *D. melanogaster*, *D. simulans*, and *D. sechellia* at different developmental stages to test the hypothesis that unpreferred codons in *D. melanogaster* tend to lower level of protein produced.

SPOCK Proteins Inhibit Neurite Outgrowth of Olfactory Sensory Neurons

DONNA Y. JIN

Under the supervision of Dr. David M. Lin
Department of Biomedical Sciences

The coordinated processes underlying axon guidance during development of the nervous system are complex and incompletely understood. Interactions between the growth cones of developing neurons and molecular signals that are secreted, bound to the surface of cells, or present in the extracellular matrix are important for guiding axons to their functional targets. Previous studies have identified SPOCK (SPARC/Osteonectin CWCV and Kazal-like domains) proteins as proteoglycans which may play an important role in neural development. Of the three SPOCK proteins, SPOCK 1 and SPOCK 2 have previously been found to have inhibitory effects on neurite outgrowth *in vitro*. In order to more fully investigate the potential roles of all three SPOCK proteins in axon guidance and growth, two neurite outgrowth assays were performed on primary cultures of mouse olfactory sensory

neurons (OSNs). In one assay, purified SPOCK protein was coated onto coverslips, serving as the culture substrate for OSNs. In the second assay, OSNs were electroporated with SPOCK DNA to drive transmembrane expression of SPOCK protein. SPOCK receptors on the growth cones of OSNs were expected to interact with externally or internally expressed SPOCK protein and influence neurite outgrowth. It was found that the presence of each purified SPOCK protein in the culture substrate led to significant reductions in neurite outgrowth and promoted clustering of cell bodies. Inducing OSNs to express each SPOCK protein via electroporation also greatly reduced neurite outgrowth. This suggests that all three SPOCK proteins are important axon guidance cues with inhibitory effects on neurite outgrowth.

How Plant Adaptation to Resource Availability Impacts Growth and Defense: A Field Experiment with 11 *Solidago* spp. (Asteraceae)

EMILY E. KEARNEY

Under the supervision of Dr. Anurag Agrawal
Department of Ecology and Evolutionary Biology

Among closely related species, there is often a diversity of resource specialists. Various hypotheses have predicted consequences of resource or habitat specialization for organismal growth and defense. In this study, I tested how experimental shading and herbivore damage affected growth and defense in eleven *Solidago* spp. from two habitats, open fields and shaded forests. Plant growth rates and larval performance of a specialist herbivore of *Solidago* spp. differed among species, but did not do so consistently between species affiliated with the two habitats. Nonetheless, growth rates did respond to shading differently across habitat classifications, with field species showing significantly reduced biomass under shading and forest species showing no effect. Diterpenes, a class of secondary metabolites, were five-fold higher in concentration among field species compared to forest species. Nonetheless, forest-affiliated species showed stronger induced responses to herbivory. In addition, when separated by light treatments, across all eleven species, plants exposed to full sun induced diterpenes while plants in the shade treatments reduced diterpenes following damage. Although the results from my study were not consistent with the resource availability hypothesis, divergent growth responses to shading and highly contrasting constitutive and induced chemical defenses were affiliated with different light environments in *Solidago*. In addition, the interaction between light environment and induction suggests that there is a common trade-off between shade responses and chemical defense.

RNase J Participates in PPR Protein-mediated Maturation of Chloroplast mRNA

SCOTT P. LURO

Under the supervision of Dr. David B. Stern
Department of Plant Biology

Nucleus-encoded ribonucleases and RNA-binding proteins exert considerable control on chloroplast gene expression through correct 5'- and 3'-end maturation, splicing, and determination of RNA stability. One mechanism for 5' mRNA maturation posits that gene-specific pentatricopeptide repeat (PPR) proteins bind RNA and define termini by blocking the 5'-to-3' exonucleolytic activity of ribonuclease J (RNase J). To investigate the relationship between these *trans*-acting factors, virus-induced gene silencing was employed to reduce the expression of several PPR proteins (PPR10, HCF152, and MRL1) and RNase J, both individually and jointly, in *Nicotiana benthamiana*. In accordance with the stability-conferring function of PPR proteins, RNA gel blot and 5' RNA end analyses revealed a severe reduction in mature RNA species upon silencing cognate PPR proteins. Both RNase J and RNase J/PPR knockdowns consistently exhibited a similar molecular phenotype: a lessened abundance of precursor and mature RNAs accompanied by an accumulation of heterogeneous and intermediate-sized 5' species. Given the deficiency of RNase J masks the compromised protective role of the PPR proteins, RNase J processes mRNA precursors bound by PPR proteins in the chloroplast.

Assessing the Stability of Viral Hemorrhagic Septicemia Virus in Post-Mortem Zebrafish

MRINALINI MODAK

Under the supervision of Dr. James W. Casey
Department of Microbiology and Immunology

In 2003, a new genotype of viral hemorrhagic septicemia virus (VHSV IVb) invaded the Great Lakes region, causing large mortality events in 2005-07 across a variety of fish species. During the years after these massive fish kills, the presence of VHSV symptoms in the Great Lakes has decreased markedly although infectious virus is continuously recovered in yearly survey work. Since the major mortality events of '05-'07, VHSV has shown a seasonal presence in the Great Lakes, with higher levels corresponding to spawning periods. Though the status of urine and ovarian fluids from infected fish as vectors of the live virus has been confirmed, the role of post-mortem fish in this horizontal transmission process has yet to be tested. As such, we hypothesized that post-mortem fish infected with VHSV may serve as reservoirs for VHSV, allowing for its persistence in the region without significant mortality events. For this study, zebrafish were infected with VHSV, euthanized upon development of hemorrhaging, and placed in one of three simulated post-mortem environments at 22°C —wet sand, water, or air—for set times (0.25 day, 0.5 day, 1 day, 2 days, 3 days, 5 days, 7 days, 14 days, and 30 days), before being collected and prepared for analysis. qRT-PCR analysis targeting the nucleoprotein gene (N gene), indicated that viral RNA was detectable for the duration of the sampling period, 30 days post-mortem, with N gene copy numbers ranging from 3.4×10^1 to 1.35×10^6 . Viral loads did not differ significantly over the three environments. Infectious virus was isolated from cell culture on epithelioma papillosum cyprini (EPC) cells up to 1 day postmortem in all environmental conditions, with infectious virus also detected in the 7 and 14 days post-mortem time points from the air environmental condition. These findings strongly suggest that VHSV may be transmitted through contact with post-mortem VHSV infected tissues.

Interdependency between Two Epigenetic Modifications at Select Loci in Mouse Chromatin

MICHAEL P. MOTLEY

Under the supervision of Dr. Paul D. Soloway
Division of Nutritional Sciences

Chromatin contains different epigenetic marks, including histone-tail modifications and DNA methylation. These marks have varying effects on the expression state of a gene at different points in development and life. However, there is evidence that these modifications do not act independently, and that interaction between epigenetic marks is necessary for proper cell function. Our previous study showed mutual antagonism between two epigenetic marks, histone 3 lysine 27 trimethylation (H3K27me3) and DNA methylation (DNAm), upstream of the *Rasgrf1* gene in mouse embryonic stem (ES) cells. H3K27me3 is deposited on chromatin by Polycomb Repressive Complex 2 (PRC2), and was shown to both restrict and be restricted by the placement of DNAm at this locus. Here, I look at the methylation profiles of DNA from wild type mouse ES cells and ES cells with a mutation in *Eed* of the PRC2 complex that results in a global loss of H3K27me3 to determine if this mutual antagonism occurs genome-wide. Using a combination of a Methyl DNA Immunoprecipitation microarray and sodium bisulfite sequencing, I show that H3K27me3 does indeed influence DNAm at numerous promoters in the embryonic mouse genome. Instead of seeing a consistent increase in DNAm after loss of H3K27me3 however, I found that only some of these promoters showed DNAm enrichment, while others showed depletion in DNAm. Additionally, several genes were shown to have both DNAm enrichment and depletion in the same promoter. My findings suggest that mutual antagonism is not observed consistently genome wide, and that more complexity exists regarding the interaction between these two marks.

Anomalous Preservation Potential of the Soft-bodied Hydroid *Plumalina* Hall, 1858 in the New York Devonian

A. DREW MUSCENTE

Under the supervision of Dr. Warren D. Allmon
Department of Earth and Atmospheric Sciences

Recent interpretations of *Plumalina* Hall, 1858 have proposed affinities with the Recent Hydroid Families Plumulariidae and Aglaopheniidae. Placement among these Leptomedusan hydrozoans is corroborated by a delicate species discovered in the Wenlockian (Lewiston Unit), the preservation of polyp bases on the holotype of *P. densa* Hall, 1878, and several *in situ* assemblages, including a turbidite with fossils preserved steeply inclined relative to the bedding plane. Morphometric comparisons are made to extant species, and affinities with the Superfamily Plumularioidea are considered. The first bivariate analysis of morphology conducted on an extinct Hydroid taxon is presented, and the systematics of the genus is revised. The biostratigraphic range is set from the Upper Silurian to Upper Devonian.

Frasnian deposits in the Ithaca Formation (Genesee Group) of New York demonstrate a quality of preservation and organismal abundance never before documented among fossil Hydroids. As opposed to *Plumalina tenera* n. sp. from the Early Silurian (represented by just one colony from the Rochester shale) and other species occurring in the Middle Devonian, *P. plumaria* Hall, 1858 and *P. brevis* n. sp. in the Ithaca Formation are represented extensively by hundreds of specimens in numerous localities. Possible origins of this preservation bias are considered. Shifts in preservation potential are explained in terms of morphological and environmental changes, and a model of evolutionary innovation and coinciding ideal taphofacies is proposed to explain the origin of these abundant assemblages.

Origin and Timing of a Recent Insular Colonization of Muskrats, *Ondatra zibethicus*

ALEXIS M. MYCHAJLIW

Under the supervision of Dr. Richard G. Harrison
Department of Ecology and Evolutionary Biology

Muskrats are semiaquatic rodents native to North America, and have become a highly successful introduced species in Europe and Asia as a consequence of their use in fur farms. Translocation by humans may have played a direct role in their colonization of several islands within the Isles of Shoals archipelago, located six miles from the Maine and New Hampshire coastline. Anecdotal and archaeological evidence suggests that muskrats arrived on this archipelago in the early 1900s, although the presence of muskrats could also be explained by historic colonization via a land-bridge 7,000-11,000 YBP. To test these hypotheses, mitochondrial cytochrome *b* for 79 muskrats and eight microsatellite loci for 85 muskrats were compared from Appledore Island, ME and NH. Appledore Island muskrats consistently displayed reduced genetic diversity as compared with mainland populations, and showed signatures of a recent bottleneck. The distribution of mitochondrial haplotypes suggests that Appledore Island muskrats derive from a NH source population. Microsatellite data reveal Appledore Island to be a distinct population cluster with high pairwise differentiation between the island and mainland regions. Appledore Island muskrats lack private alleles or unique haplotypes, suggesting that no *in situ* divergence has happened following colonization. The data presented here are consistent with a single, human-mediated introduction from NH that occurred in the early 1900s. This is the first phylogeographic study of the Isles of Shoals archipelago and it provides a unique contrast with other studies of introduced muskrat populations worldwide.

Effect of Individual Polybrominated Diphenyl Ethers Exposure on the Immune System

JESSICA A. NATALE

Under the supervision of Dr. Jerrie Gavalchin
Department of Animal Science

The effects of individual PBDEs differ by the congeners used, and the exposure dose. In this study we test the effects of PBDE-47, PBDE-99 and PBDE-209 on proliferation, cytokine production and antibody production *in vitro*. Cells came from either control-unimmunized mice or from DNP-immunized mice. Each PBDE congener showed a decrease in proliferation of Jurkat cells. Each PBDE also showed decreased proliferation in primary cells from both DNP-immunized and unimmunized mice.

Each PBDE had a different effect on cytokine production. PBDE-47 increased TH-1 associated cytokine production in cells from unimmunized control mice, specifically IL-2, IFN- γ , TNF- α , IL-6, and IL-12; PBDE-47 caused a decrease in TH-2 associated cytokines, specifically IL-10. Exposure of PBDE-47 on cells from DNP-immunized mice acted as immunosuppressive to an antigen-specific immune response. PBDE-99 showed an overall increase in the production of both TH-1 and TH-2 cytokines, particularly IL-2, IL-10, IL-12, IFN- γ , and TNF- α . Exposure to PBDE-99 in an antigen-specific immune response caused no changes in cytokine production except a decrease in IL-12 production. Exposure to PBDE-209 in cells from unimmunized control mice increase production of both TH-1 and TH-2 associated cytokines, specifically IL-2, IL-10, IL-12, and IFN- γ . Exposure to PBDE-209 in cells from DNP-immunized mice caused an immunosuppressive response in both TH-1 and TH-2 associated cytokines, decreasing the production of IL-6, IL-10, IFN- γ , and TNF- α .

Based on the data we conclude that exposure to PBDEs can modulate the immune response, especially on responses to antigens and can be immunosuppressive on a secondary immune response.

Type Matching in the Gray Catbird (*Dumetella carolinensis*)

KATE B. ORLOFSKY

Under the supervision of Dr. Michael S. Webster
Department of Neurobiology and Behavior

The study of animal signaling systems aims to understand how individuals interact to transmit information. Type matching is one mechanism used to mediate territorial interactions and occurs when a male songbird responds with a note type previously sung by a rival male. However, this behavior has primarily been studied in species with a small repertoire size, and so it is not clear whether results are generalizable to species with large repertoires. This study examines type matching in a bird with a very large repertoire, the Gray Catbird (*Dumetella carolinensis*). Males from the study population had high levels of note sharing and had a repertoire of over 200 note types, which they sang with immediate variety and maximum versatility to produce long, elaborate songs. Territorial males matched song playback stimuli at levels significantly greater than expected by chance and were more likely to match a playback stimulus than a neighboring male in a counter-singing interaction. In both playback and counter-singing trials, males delivered additional note types not found in their solo-singing note repertoire. These findings show that a species with large repertoires uses type matching and suggest that matching serves to mediate aggressive, territorial interactions. That males deliver additional note types during interactions suggests that this species may have the ability to innovate matching types on-the-fly. Given that males must choose from many possible note types to accurately match during an interaction, type matching may also indicate

male quality and convey information about male memory-retrieval abilities in species with large repertoires.

Dispersal by Overflows in a Rock-Pool Metacommunity is Trophic Level-Specific

KARA E. PELLOWE

Under the supervision of Joseph L. Simonis and Dr. Nelson G. Hairston, Jr.
Department of Ecology and Evolutionary Biology

In fragmented ecosystems, food-webs that exist within spatially separated patches of habitat are connected at the regional (metacommunity) scale by the among-patch dispersal of organisms. In the present study, I used a combination of field surveys and experiments to test the significance of one type of passive dispersal (via overflowing water) for population and food-web dynamics in a system of freshwater rock-pools on Appledore Island, Maine. This system contains a simple three-trophic-level food chain consisting of algae, grazer zooplankton (two species of Cladocera), and a predatory insect (*Trichocorixa*), all of which are passively dispersed between rock-pools when the pools overflow during rain events. A mesocosm experiment showed that all three trophic levels disperse in overflow events, and all disperse more when flow rates are higher. However, the rate of dispersal decreases significantly with increasing trophic level (*Trichocorixa* < Cladocera < algae at all flow rates). Results from a follow-up swimming capacity experiment suggest that this decrease in dispersal is due to higher trophic level avoidance of moving water, rather than an ability to more strongly swim against currents. Finally, I conducted a field experiment to determine the influence of overflows on population and food-web dynamics *in situ*. Populations in pools that were part of the experimental overflow were significantly more variable than nearby populations that were not in the overflow. This study demonstrates that passive dispersal via overflowing water alters local population dynamics and may impact food-web structure in the Appledore rock-pool system.

HCF-1 Inhibits SKN-1 to Modulate Stress Resistance but not Lifespan in *Caenorhabditis elegans*

COLETTE L. PICARD

Under the supervision of Dr. Siu Sylvia Lee
Department of Molecular Biology and Genetics

Caenorhabditis elegans host cell factor-1 (HCF-1) is an evolutionarily conserved longevity determinant. HCF-1 modulates both lifespan and stress resistance by inhibiting the *C. elegans* homolog of the mammalian FOXO transcription factors, DAF-16. However, the involvement of other components in HCF-1 mediated longevity and stress resistance has not yet been characterized. We show that SKN-1, the *C. elegans* homolog of the mammalian Nrf proteins and a major orchestrator of the phase II detoxification response that defends against oxidative stress, is regulated by HCF-1 to modulate oxidative stress resistance but not lifespan. Our findings imply a novel

regulatory relationship between HCF-1 and SKN-1 that is revealed only in the presence of oxidative stress.

Determination of Enrichment Regions for H3K27me3 and Other Low-signal, High-noise ChIP-seq Data

COLETTE L. PICARD

Under the supervision of Dr. Siu Sylvia Lee
Department of Molecular Biology and Genetics

Chromatin modifications are a major mechanism through which cells regulate gene expression. ChIP-seq allows for genome-wide profiling of any DNA-binding protein, including histones. To analyze these data, researchers have developed statistical tools that can identify genomic regions enriched for the DNA-binding protein of interest. Some histone marks, however, bind across broad regions of the genome and produce diffuse and high-noise data profiles that are often difficult to analyze. In this paper, I investigate the ability of peak-callers to analyze ChIP-seq data from H3K27me3, a histone mark known to produce broad regions of enrichment. Further, I present an alternative method that is both faster and simpler than the other peak callers investigated. This alternative method offers promise in identifying enriched genomic features when a histone mark, like H3K27me3, generates very diffuse and noisy ChIP-seq data patterns.

Tree Swallows (*Tachycineta bicolor*) Feeding on Wax Myrtle (*Morella cerifera*): Omnivory in the Floridian Winter

NATALIA C. PILAND

Under the supervision of Dr. David W. Winkler
Department of Ecology and Evolutionary Biology

The breeding biology of Tree Swallows (*Tachycineta bicolor*) is so well studied that this bird species has been proposed as a model organism (Jones 2003). However, other aspects of its biology are still poorly known. This study aims to explore the relationship between Tree Swallows (the only omnivorous bird in its genus) and one of their winter foods through systematic observations of foraging on wax myrtle (*Morella* sp.) and testing the relationship between temperature and wax myrtle foraging. Tree swallows in the Sarasota-Bradenton, FL, area were observed for a minimum of 2 hours per day for 53 days between November 3rd, 2011, and January 14th, 2012. Tree Swallows foraged more often on wax myrtle on colder days, producing a statistically significant negative relationship between maximum daily temperature and wax myrtle foraging. Despite this effect of temperature, the results of this study indicate that Tree Swallows are eating wax myrtle fruit over a broad range of temperatures at which flying insects are also available. There is still very much to learn about this fascinating behavior.

The DNA Damage Response as a Determinant of Therapeutic Sensitivity in Testicular Germ Cell Tumors

JAMIE L. RODEN

Under the supervision of Dr. Robert S. Weiss
Department of Biomedical Sciences

Testicular germ cell tumors (TGCTs), the most common cancers in young men, are exquisitely sensitive to chemotherapy, resulting in a 5-year survival rate of greater than 95% for patients with newly diagnosed TGCTs. One important determinant of the efficacy of genotoxic chemotherapeutics is the cellular DNA damage response (DDR), which is a signaling network that responds to aberrant DNA structures. Studies of human tumors suggest that the DDR in germ cell-derived tumors differs from that of tumors of somatic cell origin, and that this difference may be linked to their increased chemosensitivity. Specifically, human TGCTs lack the constitutive DDR activation seen in most pre-invasive solid tumors, and rarely have mutations in DDR genes such as p53. We hypothesize that a lack of DDR activation during early tumorigenesis eliminates selective pressure for mutations in DDR genes, and we are testing this hypothesis by: (1) examining the DDR activation status in testicular teratoma samples from the existing *Dnd1^{Ter/Ter}* TGCT mouse model and (2) developing and characterizing a new mouse model that is more reflective of the most common types of human testicular malignancies. Since TGCTs have remarkably high cure rates, understanding the DDR in these tumors may contribute to the development of new treatment pathways for deadlier cancers as well as chemoresistant TGCTs. In addition, because germ cells share many properties with pluripotent stem cells, these studies may reveal new strategies for eliminating the cancer risk associated with stem cell therapies.

Vagrancy as a Measure of Long-distance Dispersal in Cooperatively and Non-cooperatively Breeding Species of Birds

CAROLINE L. RUSK

Under the supervision of Dr. Walter D. Koenig
Laboratory of Ornithology

Cooperatively breeding birds are generally thought to be more philopatric and sedentary than non-cooperatively breeding birds, as short dispersal distances are believed to have contributed to kin selection and the evolution of cooperation. I tested this hypothesis by comparing vagrant records for matched pairs of North American cooperative and non-cooperative breeders. Results failed to support the hypothesis of greater philopatry among cooperative breeders, which disperse the same long distances and with the same tendency as non-cooperative species. These results suggest the possibility of an observational bias in studies of dispersal in cooperative breeders and counter the hypothesis that philopatry is key to the evolution of cooperative breeding.

Reproductive Success and Body Size in the Cricket *Gryllus firmus*

NICHOLAS W. SALEH

Under the supervision of Dr. Richard G. Harrison
Department of Ecology and Evolutionary Biology

Variation in male body size influences mate choice and sexual selection in many animal species. Here we investigate the role of male body size in the reproductive success of the field cricket *Gryllus firmus*. Study of mate choice in *G. firmus* is of particular interest because this species hybridizes with a close relative, *Gryllus pennsylvanicus*, which is typically smaller than *G. firmus*. It is thought that the size difference may affect reproductive isolation between the species. We examined the role of male body size in the reproductive success of *G. firmus* by pairing large and small males with single females and genotyping a sample of the resulting offspring using highly polymorphic microsatellite markers. Overall, larger males sired a greater number of offspring. We also found that, in a majority of the crosses, a single male sired all of the offspring. In these crosses, the larger male sired more offspring. In crosses where both males sired offspring there was no difference in the proportion of paternity between small and large males. Intrasexual competition, female choice, and differences in ejaculates between males could all influence the patterns observed in our data. Evidence for the influence of female choice, however, is especially strong. Our findings support the hypothesis that body size differences constitute a barrier to gene flow between *G. firmus* and *G. pennsylvanicus*.

Sublesional Changes to the Hindlimb Central Pattern Generator after Spinal Cord Injury in the Mouse: Investigating the Loss of Serotonin Transporter, and Dynamic 5-HT_{1A} Receptor Expression

MOIRA M. SCAPEROTTI

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

The hindlimb Central Pattern Generator (CPG) in the lumbar spinal cord coordinates rhythmic movement for locomotion. It is composed of many interneuron classes that produce glutamatergic synaptic drive on the motor neurons responsible for the flexor-extensor alternations in one limb, and side-to-side alternations between left and right limbs. Serotonin enables locomotion through its various effects on the CPG. We were specifically interested in the serotonin system and V2a interneurons, one class of CPG participants. Others have shown, and we verified here, that spinal cord injury (SCI) produces an almost complete loss of serotonin in the spinal cord below the lesion because the injury cuts the descending serotonergic input from the brainstem. Past work from our laboratory demonstrated that V2a interneurons in the lumbar spinal cord of mice with complete thoracic SCI are supersensitive to serotonin. In addition, the serotonin receptor 5-HT_{2C} is upregulated after SCI-induced serotonergic denervation. We suspected that the serotonin transporter, SERT, which is predominantly expressed on serotonergic fibers, would also be lost sublesionally

after SCI. We also asked whether another serotonin receptor, 5-HT_{1A}, would display similar expression changes due to SCI. Using immunocytochemical methods, we found that SERT immunoreactivity is significantly decreased in SCI mice, although the SERT loss is not as profound as that found in other SCI-animal models. Finally, preliminary evidence with 5-HT_{1A} suggests that the receptor is actually downregulated after SCI, contrary to others' findings. This work contributes to our lab's continued effort to define the normal and SCI-induced characteristics of the hindlimb CPG.

Characterization of the Plant Immune Response to Bacterial Pathogen-associated Molecular Patterns

KATHERINE E. SCHEIBEL

Under the supervision of Dr. Gregory B. Martin
Department of Plant Pathology and Plant-Microbe Biology

An important component of plant defense against microbial attack is the pathogen associated molecular pattern (PAMP) triggered immune system. In this system, the plant uses pattern recognition receptors (PRRs) to recognize PAMPs, which are typically indispensable components conserved in broad classes of microbes. This recognition then initiates a signal transduction pathway resulting in multiple defense responses, including production of reactive oxygen species (ROS) and callose deposition at the plant cell wall. I report here that a wild relative of tomato, *Solanum pennellii*, when pre-exposed to flg22, a PAMP of the bacterial protein flagellin, has an increased immune response to the bacterial pathogen *Pseudomonas syringae* pv. *tomato*. The *S. pennellii* genomic region associated with this enhanced immunity contains the gene *SIFs2*, a known pattern recognition receptor, and a tandemly duplicated copy, *SIFs2.2*. Additionally, I have found evidence that the same pattern recognition receptor, SIFs2 and its homolog AtFls2 in *Arabidopsis thaliana*, recognizes a second PAMP, a portion of the bacterial cold shock protein. Finally, I have shown that the cold shock protein is essential for bacterial growth *in planta* and therefore could constitute an effective target for PRR recognition.

The Effect of DMSO and DIOA on Transepithelial Fluid Secretion in Malpighian Tubules of *Aedes aegypti*

MATTHEW SCHEPEL

Under the supervision of Dr. Klaus W. Beyenbach
Department of Biomedical Sciences

In vertebrate and invertebrate epithelial tissues, K₂Cl cotransporters (KCCs) participate in the regulation of transepithelial transport of salt and water. This study seeks functional evidence for the presence of KCC in the Malpighian tubules of the Yellow Fever mosquito *Aedes aegypti* by comparing transepithelial fluid secretion rates in isolated Malpighian tubules in the presence and absence of dihydroindenylxyalkanoic acid (DIOA), a known inhibitor of KCC. Using the Ramsay

assay, this study shows that the vehicle of DIOA, namely DMSO, has no significant ($p < 0.05$) effect on transepithelial fluid secretion rates under stimulated conditions when used at a concentration of 0.05% DMSO. The KCl cotransport inhibitor DIOA (10 μ M in 0.05% DMSO) significantly decreased the rate of transepithelial fluid secretion in both control tubules and in tubules stimulated by diuretic agents. In unstimulated control tubules, the addition of DIOA to the peritubular Ringer bath significantly ($p < 0.001$) decreased mean fluid secretion rates by 60%. In tubules stimulated with dibutryl-cAMP, the addition of DIOA significantly ($p < 0.05$) reduced fluid secretion rates by 68%. Likewise, DIOA significantly ($p < 0.05$) inhibited the rate of fluid secretion by 62% in tubules stimulated with the diuretic peptide aedeskinin-III. We know from other studies in our laboratory that KCC is located at the apical membrane of principal cells of the tubule, where it is thought to extrude K^+ and Cl^- from the cytoplasm to the tubule lumen. Taken together, these studies reveal the central role of KCC in transepithelial fluid secretion in Malpighian tubules of *Aedes aegypti* under both control and diuretic conditions.

The Effects of Pyoverdine on Styrene Degradation by *Pseudomonas putida* F1

MARY K. THOMPSON

Under the supervision of Dr. Anthony G. Hay
Department of Microbiology

It was previously believed that *Pseudomonas putida* F1 was unable to utilize the industrial byproduct styrene as a sole carbon source. However, it was recently discovered that styrene adapted mutants, dubbed *P. putida* SF1, spontaneously arise over a period of weeks when *P. putida* F1 is grown on styrene. These mutants' ability to utilize styrene as a sole carbon source, as well as F1's ability to degrade a large range of aromatic compounds, comes from its toluene dioxygenase (tod) pathway. The tod pathway is composed of an upper and lower segment. When *P. putida* F1 is grown on styrene, a product of the upper pathway of the tod operon deactivates an enzyme in the lower pathway. This block prevents carbon flow to the TCA cycle and allows the accumulation of a toxic substance in the cell. In *P. putida* SF1, the rate of production of the toxic compound was slowed due to a single base pair mutation in an upper pathway enzyme. This "less is more" strategy allowed the lower pathway to keep up without being deactivated, permitting growth on styrene. Interestingly, it was found that this was not the only adaptation *P. putida* SF1 had made for growth on styrene. In this paper, we show that *P. putida* SF1 overproduces the iron chelating molecule pyoverdine. This provides more iron to the iron dependent enzymes of the tod operon, decreasing the ratio of upper pathway to lower pathway activity, thus allowing for more robust growth on styrene.

Interactions of Native and Exotic St. Johnswort with an Introduced Biological Control Agent

JESSICA L. TINGLE

Under the supervision of Dr. Anurag Agrawal
Department of Ecology and Evolutionary Biology

One way to curb the spread of invasive species is by biological control, the practice of releasing specialist enemies to combat the intruder. These specialist enemies may have unintended effects on native species, particularly if those natives are closely related to the target species. We explored the possibility of such unintended effects in a system involving the invasive weed *Hypericum perforatum*, a native congener *H. punctatum*, and the biological control agent *Chrysolina quadrigemina*. We explored the effects of *C. quadrigemina* on native *Hypericum* species by asking the following two questions: 1) Does the beetle preferentially exploit the native or exotic *Hypericum* species? and 2) Does beetle herbivory influence the natural distribution of *H. punctatum*? To address these questions, we used a combination of natural field surveys and experimental manipulations including a planted transect, a 2x2 factorial manipulation, and feeding assays. Several important results came from this set of experiments and natural surveys. First, the introduced biocontrol beetles preferred native *H. punctatum* over exotic *H. perforatum*. Second, *H. punctatum* is concentrated near the forest edge in natural settings even though it appeared to perform better in the sun than in the shade in natural surveys and in the sun/shade experiment. Third, contrary to expectations, all plants in the transect experiment and in natural distribution surveys received decreased herbivory farther away from the forest edge.

Sperm Binding in the Bovine Oviduct: The Differential Distribution of Annexins on Oviductal Epithelium

THOMAS F. YAROS

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

In many mammals, females store sperm in temporary reservoirs that are created when sperm bind the epithelium lining the isthmus of the oviduct. In bovine, binding occurs between three bovine seminal plasma proteins on the sperm head and four annexin proteins on the oviductal epithelium. With evidence that sperm predominantly bind the epithelium of the isthmus, we hypothesized that annexins are differentially distributed throughout the oviduct. Oviducts were surgically obtained from cows and segments of four regions were removed from each oviduct: lower isthmus, upper isthmus, lower ampulla, and upper ampulla. Histological sections were prepared from each segment. The sections were immunohistochemically stained for each of the four annexins. A system was developed to measure the density of staining using an Aperio Scanscope, an ultra-resolution digital scanning system, and Aperio Spectrum image analysis software. Stained sections were scanned and digitized into image files that could be magnified 400X. An algorithm determining staining density was run on regions sampled from the mucosal epithelium on each section that produced percentages of annexin staining on the apical portion of the epithelium. The sections were evaluated for staining differences between regions and it was noticed that the tips of epithelial folds stained differently than basal pockets between them. Percentage data were normalized, and ANOVA and post-hoc tests were used to detect significant differences in staining between regions. Post-hoc tests showed a difference in annexin staining between regions for two of the four annexins. In conclusion, annexins are differentially distributed throughout regions of the oviduct.

Progranulin Regulation through Its Interacting Partners: Sortilin, Galectins, and Fbx2

YANQIU ZHENG

Under the supervision of Dr. Fenghua Hu
Department of Molecular Biology and Genetics

Progranulin haploinsufficiency is the primary cause of frontotemporal lobar degeneration (FTLD) with TDP-43 aggregates. Previous studies have shown that sortilin is able to regulate progranulin trafficking and governs the amount of progranulin in the brain. In this study, we mapped the binding site between progranulin and sortilin. Progranulin binds to sortilin through its C-terminal tail, and deletion of progranulin's last three amino acids abolishes this binding and sortilin-dependent regulation of progranulin trafficking. Furthermore, members of the galectin family and Fbx2 were found to interact with progranulin, and progranulin is able to upregulate both galectins and Fbx2. Likewise, galectins and Fbx2 were found to upregulate progranulin levels. Since progranulin haploinsufficiency results in FTLD, these results may provide insight into future studies involving progranulin signaling and possible FTLD therapies.

Sanitizing the Respectable and the Rotten in the Tenement and the Excretory Oasis: How to (Un)Build Bodies, Material Worlds and Identities

STEVEN R. BENAY

Under the supervision of Dr. Sara B. Pritchard
Department of Science and Technology Studies

‘Public comfort stations’ materialized at the turn of the 20th century in a way mutually elaborative of reformers’, engineers’, and planners’ project of ‘sanitizing’ the ‘slums.’ Comfort stations were materially embedded and (re)materialized as possibilities produced by arrangements of a historically-contingent “assemblage.” This framework (influenced largely by the work of Michelle Murphy and others) reveals how comfort stations’ bounds, capacities, workability and meaning, and new bodies that were comforted, threatened or offended by new dangers, objects, and sensations, made possible (white) bourgeois ladies and gentlemen with disciplined and respectable bodies and raced working class tenement dwellers with undisciplined ‘rotten’ bodies conceived as breaches of those masculinities and femininities. Reformers fabricated potential ‘alternative’ practices in tenements into new entities, problems to be solved. These knowledge-making traditions, including tenements, excreta, stinks, bathroom tiles and other ‘things,’ could have been, and were, otherwise. The material, the body, and the person were multiplicitous, materialized by *many* knowledge-making traditions. Municipal housekeeper Clubwomen challenged the notion that ladies should be confined to four walls of reformers and materializations of ‘comfort stations,’ but resisted drawing on entities that subtly reconstituted ‘women’s place’ and ‘slumdweller.’ Residents’ assemblages produced possibilities running counter to or across those earlier mentioned materialities and identities, sometimes rendering imperceptible ‘the tenement house problem.’ ‘Resistance’ was materialized through entities that reproduced gender, race and class. The thesis ‘cracks open’ the black-box: the attribution of bounds and capacities to material worlds and bodies is a process of the interpellation of the subject.

Aamaas and Alcohol: Transitions of Breastfeeding and the Health Care System Among Thakali Women in Mustang District, Nepal

CAITLIN N. DREISBACH

Under the supervision of Dr. Andrea Parrot and Dr. Saurabh Mehta
Department of Policy Analysis and Management / Division of Nutritional Sciences

The present study investigates the practice of home-brewing beer (*chhyang*) to promote lactation among Thakali women in Mustang District, Nepal. The Thakalis are an indigenous ethnic group historically known as *matuwali* or “alcohol drinking peoples.” Thakali women from five towns in the Mustang District (n=37, mean age = 42) voluntarily participated in semi-structured interviews. Interview topics included questions regarding the cultural significance of brewing beer, breastfeeding, consumption of beer for lactation enhancement, and the socio-cultural and health care factors that may have influenced changes in traditional breastfeeding practices. Results showed that

seventeen women (45.9%) consumed *chhyang* (Nepali grain beer) during breastfeeding to promote milk production, ten women (27%) did not, one (3%) ate the *chhyang* solid (the fermented grain product) and nine (24.3%) had not yet breastfed because they did not have children of their own. Informants said they drank *chhyang* to encourage milk production and increase energy. Women cited maternal encouragement, cultural precedent and traditional medicine as reasons for *chhyang* consumption. The majority of women feel that *chhyang* consumption increases milk yield. Of the informants who did not drink, over 75% based their choice upon a doctor's recommendation. The introduction of health posts in Mustang is a factor influencing women's perspectives and practices of *chhyang* consumption.

Burning Questions: Negotiating Credibility in Fire and Arson Investigation

MICHELLE J. SPEKTOR

Under the supervision of Dr. Michael E. Lynch
Department of Science & Technology Studies

In recent years, fire and arson investigation has undergone a significant amount of scrutiny. The public, government agencies, forensic scientists, and even some fire and arson investigators themselves perceive the field as an adversarial space where current, "scientific" arson experts come into conflict with purportedly old-school, "junk-scientific" arson investigators. For the last two decades, the field has been in the process of professionalization and scientification, transitioning from a field whose experience-based expertise was transferred in a guild-like, decentralized fashion, to a field that maintains unified, codified and authoritative procedural standards considered to be rooted in science. This paper unpacks the processes of professionalization and scientification that negotiate construction of credibility in fire and arson investigation by considering (i) the establishment of scientific standards for the admissibility of expert evidence in court by *Daubert v. Merrell Dow Pharmaceuticals* and *Kumho Tire Company v. Carmichael*, and (ii) the discovery of new information about fire dynamics and arson indicators. Fundamental questions about the role of science in the construction of credible knowledge systems and the delivery of justice are raised. These analyses suggest that the field of fire and arson investigation is a contentious space whose professional and scientific potentials and realities are shaped by complex interactions of actors, institutions, events and other agents of change, rather than a binary framework of science vs. non-science that other perspectives tend to embody.

Phenoloxidase Activity in Insects: Insights from Aphids and Microbe Free Fruit Flies

MICHAEL A. GARVEY

Under the supervision of Dr. Angela E. Douglas
Department of Entomology

Organisms are constantly being manipulated by parasites, and thus have evolved complex immune responses to moderate these interactions. With the recent completion of *Acyrtosiphon pisum*'s, the pea aphid, genome it was shown that aphids have a reduced number of immune related genes compared to other insects, but correlating fewer immune genes to actual reduced immune activity has not been completely established.

Here I tested for differences in phenoloxidase activity between *A. pisum*, *Podisus maculiventris*, and *Drosophila melanogaster* to begin to address this gap in experiments. I also tested for differences in phenoloxidase activity in axenic and conventional *D. melanogaster*, given new data suggesting that axenic *D. melanogaster* have lower expressed immune genes, and to my knowledge this is the first time a researcher has compared axenic and conventional individuals of the same species for differences in immune activity.

I show that *A. pisum* do not have reduced phenoloxidase activity compared to the other insects sampled, and that axenic and conventional *D. melanogaster* do not have statistically different levels of phenoloxidase activity.

Further tests are needed to address why this might be, but one possibility is that insects, after standardization for size, maintain similar amounts of phenoloxidase in order to tan and sclerotize their cuticle during molting, wound healing, and embryogenesis.

Mosquito Species Composition, Host Feeding Patterns, and Eastern Equine Encephalitis (EEE) Infection Status in EEE Foci in Maine

REBECCA M. JOHNSON

Under the supervision of Dr. Laura C. Harrington
Department of Entomology

Eastern Equine Encephalitis (EEE) is mosquito-borne virus that is dangerous and often fatal for humans and unvaccinated horses. Little is known about the biology of this virus or which mosquitoes could be responsible for transmission to mammals. Basic ecological knowledge of the mosquitoes present in Maine is also lacking.

This study aimed to gather data on species composition, general abundance, effective trapping methods, and EEE infection status for Maine mosquitoes. Mosquitoes were collected during the

summer of 2010 from three Maine counties, Somerset, Penobscot, and Waldo, where EEE had not been detected until 2009. The towns of Unity and Palmyra/Newport were chosen as collection foci based on reported EEE case distribution. Collections were conducted using vegetation aspirators, resting boxes, and CDC traps.

A total of 5,352 female mosquitoes belonging to 18 species were collected. The first *Culiseta minnesotae* specimens from Somerset, Penobscot, and Waldo Counties were collected during this survey. Putative EEE bridge vectors, *Culiseta melanura*, *Cs. minnesotae*, *Coquillettidia perturbans*, and *Aedes fitchii/stimulans* were further analyzed for the presence of EEE viral RNA using RT-PCR. All of the 191 pools (4,589 mosquitoes) tested were negative for EEE.

This study represents the first examination of putative Maine vectors of EEE and provides updated information on mosquito species composition in Maine.

Cutting Barriers: African Refugee Women and American Healthcare

MARGAUX C. GENOFF

Under the supervision of Dr. Saida Hodžić and Dr. Judith A. Byfield
Department of Anthropology / Department of History

This study is an anthropological investigation with the objective of identifying the barriers to obstetric and gynecological preventive care for Oromo and Somali refugee women. Siouxland is a vernacular area around the Big Sioux River at the intersection of South Dakota, Nebraska and Iowa. Currently, and for the past decade, African refugees are the new face of immigration to this area that is known for methodological nationalism. To analyze the various obstacles to care, the methodologies for this project are interviews with approximately 50 African refugees, nurses, medical assistances, physicians, immigration advocates, and community members along with participant observation and literature review. The study reveals that there are two separate categories of barriers: barricades to entering the medical space for the refugees and barriers for healthcare practitioners to providing dignified care within the medical space. Obstacles to entering the medical space are cognitive barriers due to the lack of trust of biomedicine and the privatization of health insurance. There are two barriers to providing care within the medical space. First, the ideas surrounding “cultural competent care” promoted the reductionist idea of culture being static and uniform. Secondly, the tension caused by the politics of English created conflicts over control, that at times resulted abuses of power by way of verbal coercion and patient abuse. This research has important implications for providing opportunities to access dignified care not only for the African refugee community, but also for all those within America’s borders that have fallen through the cracks.

The 9/11 and Vietnam Veterans Memorials: Interpreting Experience in the Landscape of Loss

LAURA M. DURGERIAN

Under the supervision of Dr. Paula H. Horrigan and Dr. Peter Trowbridge
Department of Landscape Architecture

Experiential memorials are agents of memory, constructing experiences for visitors that evoke memory, emotion, and thought. This project begins by defining the ‘language of loss’ and exploring the role of memorials through a literature review. It then investigates two seminal built memorials in order to gain a fuller understanding of how each employs this language of loss. Research into the contextual development of these memorials – Maya Lin’s Vietnam Veterans Memorial (1982) in Washington D.C., and Michael Arad and Peter Walker’s 9/11 Memorial (2011) in Lower Manhattan – provides a framework for interpreting each work.

Following preliminary literature and design research, a series of on-site research methods were undertaken to record and map the experience of visitors to each memorial. This process intends to reveal to what degree each memorial exemplifies this definition of the experiential memorial. Research strategies included the author’s personal experience narrative, observations, photography and face-to-face interviews with visitors. Findings from this interaction, as well as interviews with knowledgeable individuals connected to each memorial, then informed a comparison of both memorials and suggestions for the design of future memorials. The findings and outcomes of this thesis aim to provide designers and scholars with knowledge of how to conceive and construct meaningful memorials that impact users and contribute to cultural memory.

Resiliency through Nature: Comparing Place-Based Biophilia among Somali Bantu Women in Utica, New York

SARAH E. HERMES

Under the supervision of Dr. Paula H. Horrigan
Department of Landscape Architecture

As the numbers of refugees from contemporary natural disasters and political conflict increase globally, there is greater need to understand the importance of place attachment, biophilia, and restorative nature in the lives of those experiencing profound distress and displacement. An emergent body of literature reveals that an individual’s adaptive capacity and resilience increases through contact with nature, and is therefore vital to the successful resettlement of refugee communities (Sheldrake 2001).

This thesis researches the experiences and perceptions of nature of six Somali Bantu women residing in Somalia, Kenyan refugee camps and currently, Utica, New York, and aims to support the longer term unfolding research effort related to Utica’s One World Garden Project. Narrative interviews with each of the individual participants were conducted using photograph elicitation and emergent interviewing

techniques. From these interviews a series of recurring themes emerged revealing that despite distressing conditions and seemingly barren landscape settings, nearly all participants attempted to cultivate a nearby garden space in their refugee camp. Such garden spaces and their plantings offered participants a source of healing, pride, memory and overall wellbeing. Once settled in Utica, NY, the participants continued to engage in practices of gardening, citing similar reasons and benefits. These findings offer evidence that an active human-nature connection, demonstrated through place attachment and biophilic tendencies, can be considered to be both an indicator of and a contributor to greater resilience for individuals experiencing extreme levels of distress and displacement.

Investigating the Forest Invertebrate Trophic System through Stable Isotope Analysis

KADEEM J. GILBERT

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

Stable isotopes are important in ecological research, especially in understanding trophic interactions amongst different organisms. This study took place in the Arnot Teaching and Research Forest in Central New York State. Both roots and litter of sugar maple trees were labeled with carbon and nitrogen isotopes. Arthropods were collected from the forest floor on five dates (spring 2008, fall 2008, spring 2009, fall 2009, and spring 2011) by means of Berlese funnels. The arthropods were sorted into broad taxonomic groups (order or family level), dried, weighed, and analyzed for isotopic content. Key taxonomic groups examined in this study include Acari, Araneae, Chilopoda, Diplopoda, Collembola, Hymenoptera, Coleoptera, and Curculionidae. The change in the carbon 13 to carbon 12 ratio ($\delta^{13}\text{C}$) was examined over time per taxon. The excess ^{13}C pool in invertebrate biomass was also examined over time per taxon. The data showed different patterns depending on taxon with regards to levels of $\delta^{13}\text{C}$: Hymenoptera showed exceptionally high isotope enrichment in comparison to the other groups. All taxa generally showed some increase in enrichment over time followed by a significant drop in isotope concentration in the last date. The dilution of the isotope label suggests that the turnover time of the belowground food web in these forests is a little more than a year, driven primarily by turnover of fine roots and rhizosphere carbon. High $\delta^{13}\text{C}$ enrichment of litter layer invertebrates when $\delta^{13}\text{C}$ was supplied only via the root system indicates the predominance of belowground carbon inputs in supplying the forest floor invertebrate food web.

Ecology of the Opossum Shrimp, *Mysis diluviana*, in Lake Champlain

ALLISON R. HRYCIK

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

This study examines the ecology of the opossum shrimp, *Mysis diluviana*, as a planktivore in Lake Champlain. Diet, consumption, growth rate, and generation time of *Mysis diluviana* (formerly *Mysis relicta*), differs between lakes depending on what resources are available. We used hydroacoustics, diet analysis, and cohort analysis techniques to determine mysid abundance, consumption, and growth rates. Hydroacoustic surveys reveal that there are approximately 22 mysids per m^2 in deeper parts of the lake. Diets were examined using both gut content analysis and stable isotope analysis, which revealed that mysids consume a large biomass of cladoceran zooplankton. Mysid cohorts were measured at various points throughout the year, which allowed us to determine growth rates. These data were used to fit a bioenergetics model to determine the importance of *Mysis diluviana* in the ecosystem.

Forest Recovery and Regeneration Following a Simulated Hurricane

MEREDITH E. KUENY

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

Hurricane disturbance is an infrequent but important disturbance in forests of the Northeastern United States, impacting species distributions and ecological services. In 1990 researchers at the Harvard Forest simulated a catastrophic hurricane on a 0.8 ha plot of a red oak and red maple dominant temperate forest in Petersham, MA. Initial studies sought to understand the short-term impacts of disturbance on nutrient cycling. While nutrient cycling seemed to be largely unaffected by the disturbance, our study came back to the disturbance site 10-20 years after the simulation to examine how Aboveground Net Primary Production (ANPP) was recovering, and to ascertain what lasting effects on species composition and species interactions remained. We found that only 10 years after disturbance, ANPP had already recovered to pre-disturbance levels, but aboveground carbon stocks were 1/3 to 1/2 the magnitude of those in the control plot. In addition, trees that survived the initial disturbance were depressing the growth rate of new trees, and forest composition had changed from a red oak and red maple dominant forest to a red oak and black birch dominant forest.

Identification, Characteristics, and Patterns of Use of Scent Marking Trees by African Cheetahs (*Acinonyx jubatus*)

ANNA E. KUSLER

Under the supervision of Dr. Paul D. Curtis
Department of Natural Resources

Male African cheetahs are known to scent-mark their territory by spray marking, scratching, and defecating on prominent features in the landscape such as trees. Several studies have placed camera traps at these scent-marking trees to investigate abundance, but the use of these trees by cheetahs remains largely unexplored. The aim of this study was to better understand the function and ecology of marking trees and how they are used within the territory of a two-member coalition of adult male cheetah. We sought to determine spatiotemporal use, behavioral responses to conspecifics, and the physical attributes of the trees themselves. The study was two-part: marking-trees were first searched for, located, and mapped in respect to the territory of the study individuals. Trees were found opportunistically or by identifying clusters of location data collected from a male cheetah fitted with a GPS collar. Once trees had been found, camera-traps were deployed to assess specific marking behavior at trees in varying areas of the territory. Thirty active marking trees were located in the study. A trapping effort of 334 trap nights resulted in 1685 photographs of which 10.21% (n = 165) were cheetah photographs. A total seven individuals were detected, five males and two females. 93.4% of the visits were by male individuals. This may suggest that the primary function of scent-

marking trees is communication between males. Therefore by themselves, marking trees may not be a fully reliable tool for population and demographic information.

The Accumulation of Contaminants in Urban Stormwater Detention Basins

RACHEL M. K. PERLMAN

Under the supervision of Dr. M. Todd Walter
Department of Biological and Environmental Engineering

In this study we examined whether infiltrating detention basins effectively accumulate contaminants, thus reducing stormwater pollutant loads entering streams for nine basins on the Cornell University campus. Composite soil samples (10 cm deep) were taken from each basin at the inlet, pool area, and a control, specifically the basin's upper periphery, which did not contact runoff. Samples were analyzed for select metals (Cd, Co, Cr, Cu, Ni, Pb, Zn), cations (Ca, K, Mg, Na), P, and S. Using control samples as a baseline, most basins were generally accumulating, i.e. within pool/inlet areas, 8 of the 13 elements (Cu, Pb, Zn, Ca, Mg, Na, P, S), depleted in 4 elements (Co, Cr, Ni, K), and Cd was generally below our minimum detection limit. But these trends were inconsistent and often the differences between the pool/inlet and control were not significant (95% confidence). Only Zn, Na, and S were significantly enriched in the pool/inlet areas for more than half the basins and Co and K were significantly depleted at more than half the basins. Three of the basins were uniquely depleted in 5 or more elements and, perhaps not coincidentally, at least one of these had the highest average pool-concentration for 8 elements and the highest average control-concentration for 10 elements. We speculate that these basins were amended with biosolids during construction, presumably as a carbon source. These results suggest that improved understanding of pollutant removal from stormwater is needed to develop more consistently effective designs.

Fungi Associated with Spores of Glomeromycota at Hubbard Brook Experimental Forest, NH

ANNA K. PLATTNER

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

Arbuscular mycorrhizal fungi (AMF, phylum Glomeromycota) are obligate endosymbionts known to colonize the roots of most terrestrial plant species and highly influence plant community dynamics and diversity. In their symbiosis, AMF acquire all their carbon from the host plant and in return give the plant a range of benefits, such as increased phosphorus uptake. AMF asexual spores are packed with lipids, which are attractive targets for natural points of attack to parasites. We evaluated colonization of AMF spores by other species of fungi. Ten soil samples were taken from both hummocks and hollows in a northern hardwood forest, White Mountains, NH. Each intact spore was rRNA gene sequenced, and the resulting sequences were aligned with named references and phylogenetic trees were constructed. Successful rRNA gene sequences were obtained from 82 spores

total. Only one of these was an AMF individual (*Ambispora fennica*). The others were colonized by lower fungi Mucoromycotina (three spores), fungi in Ascomycota (57 spores) and Basidiomycota (19 spores), as well as a eukaryotic amoeba (one spore), and an alga (one spore). This unexpectedly high amount of colonization of AMF spores confirms the potential for spores to be targets of colonization by other fungi. Whether the invading fungi were parasites or saprobic organisms is unknown, but the pattern reflects an ecological process. This study shows that using spores to identify AMF is problematic because spores can be colonized, even though they still appear viable. Fungi that attack AMF could be a real obstacle to studying Glomeromycota because colonization affects both morphological and DNA characteristics of the spore.

Conservation Biology of the White-naped Tit (*Parus nuchalis*): Roosting Behavior and Territoriality

ARJUN B. POTTER

Under the supervision of Dr. André Dhondt
Department of Ecology and Evolutionary Biology

The White-naped tit (*Parus nuchalis*), an endemic of the Indian subcontinent, is a small, secondary cavity nesting bird species that might disappear even before its basic natural history is described. It is listed as Vulnerable due to loss of its tropical thorn forest habitat. In the summer of 2011, at the start of the breeding season, I studied a small population in Kutch district, Gujarat, India, focusing on roosting and territoriality. Cavity nesting passerines often use cavities for roosting, although rarely during the breeding season. The male tit of one breeding pair retired to the roost in an extremely small cavity on average 17.25 minutes after sunset, engaging in behaviors that suggest predator avoidance. Inclement weather coincided with earlier roosting times. The female remained in the nest cavity at night. It was possible to distinguish individuals of three pairs through plumage differences. Territories of these pairs were mapped using confrontations (using a GPS) and point sightings. Territories were very large: 28.9 ha and at least 46.2 ha. Large territory sizes are likely the result of low habitat quality in this *Acacia senegal* dominated forest. Low observed breeding densities suggest that overall population size would be even smaller than previously suggested. The species seems to be threatened by deforestation and the removal of cavities through selective logging of dead trees. Cavities might be limiting not only because of a shortage of nest sites but also because of a shortage of roost sites.

Plant Species and Diversity Effects Override the Effects of Plant Origin in Determining Larval Tadpole Performance

SHAUNA-KAY D. RAINFORD

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

Plant detritus often provides >90% of the energy and materials in aquatic food webs, yet few studies have tested the impact of plant detrital traits on larval amphibian growth and survival. In order to explore this topic, I reared *Anaxyrus americanus* (American toad) larvae individually in 1 L outdoor mesocosms in 24 plant litter treatments. The treatments included 15 native species treatments, 9 non-native species treatments, and four diversity treatments (1, 3, 6, 12 species; 30 replicates/treatment for a total N =840). From 24 May to 12 August 2010 I monitored larval survival, development rate, and size at metamorphosis (weight and snout-vent length). I also collected data on the abiotic condition of mesocosms (pH, dissolved oxygen, temperature, and conductance) and litter traits (C, N, P and lignin levels). I tested the null hypothesized that larval performance would not differ based on plant species or plant origin, and increasing plant litter diversity will not increase larval survival or reduce larval development time. Larval tadpole survival and time to metamorphosis varied significantly among plant species, but plant origin was not a predictor in explaining these effects. Water pH and C:N were the two factors that were included in the greatest number of larval performance models, but other litter traits were also relatively important in predicting larval performance. These results indicate that plant species identity is more important in explaining the performance of larval *A. americanus* tadpoles than plant origin

The Paradigm Shift to a Sustainable Economics at Cornell University

DENISE S. ROBBINS

Under the supervision of Dr. Steven A. Wolf
Department of Natural Resources

The world is facing several catastrophic events, both economically and environmentally. They are inherently economic in nature and call for a change in economics to a new paradigm. There are several new theories for replacement paradigms, necessitating a paradigm shift. Universities play an important role in paradigm shifts, as youth is one of the critical components, along with those performing research within the discipline and relevant disciplines. A case study was performed at Cornell University to determine the state of paradigm shift at this university. In order to accomplish this, a representative sample of the student population was surveyed and professors in economics-related departments were interviewed. The students were surveyed to gauge their demographics, values, agreement with principles and policies of the new paradigms, and interest in the new paradigms. The professors were interviewed to learn in which phase each department might lie for a paradigm shift. It was found in this study that we are in crisis mode. As a whole, the student body is high in the scale of the necessary values, but one paradigm hasn't been selected yet, and the

curriculum hasn't changed at all to reflect a paradigm shift. The professors interviewed showed a range of interests, some working in the normal paradigm, others critiquing and finding new ones. There are still key components and catalysts needed to be a complete paradigm shift.

The Relationship Between Forest Successional Age and Non-native Earthworm Distribution and Abundance

WADE P. SIMMONS

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

The objective of this research was to test the relationship between forest maturity and non-native earthworm distribution and abundance. Distribution patterns of non-native earthworms in the Northeast are not fully understood, and forest maturity is a variable that has not received adequate attention as a possible regulator of distribution. Aerial photographs and satellite imagery were compiled and analyzed to determine the temporal conversion of land from an agricultural use to a closed-canopy forest. Three study sites were fields that had been abandoned and forest succession subsequently occurred. Within these sites, a sample scheme was developed to test the earthworm community throughout the forest maturity gradient. The study's results revealed a weak inverse relationship between forest age and earthworm abundance, with younger forests containing the most worms and mature forests containing the least. Variation between sites revealed that forest age alone is not enough to explain earthworm distribution and abundance, although it is a factor that should be considered. While unable to single out forest maturity as the controlling variable for non-native earthworms dispersion, this research highlights the importance of using an experimental design that addresses multiple factors that can be isolated to address the mechanism controlling successful earthworm colonization.

Abundance and Diversity of Small Mammals in Relation to Varying Degrees of Woody Material Retention

FUMIKA TAKAHASHI

Under the supervision of Dr. Stephen J. Morreale
Department of Natural Resources

In light of recent developments in woody biofuel production, management of woody material removal from the forest floor of northern hardwood forests is essential to the forest biota, in particular, small mammals. To measure the response of small mammals to varying degrees of woody material retention in managed forests, track tubes and visual count surveys were used to assess the relative abundance and species diversity among three treatments of woody material removal. The results indicate a species-specific recommendation of higher amounts of woody material (10 inches diameter) for the eastern chipmunk (*Tamias striatus*) and the red-backed vole (*Myodes gapperi*): smaller 4 inch diameter woody material may not provide enough structure to support small mammal

habitat. Although more research is needed in order to determine an exact intermediate threshold, it is likely that retention of woody material less than and equal to 6 to 8 inches will maximize small mammal abundance and diversity.

Economic Globalization, Tropical Deforestation, and Certification: The Role of Transnational Corporations Driving Sustainable Forestry in Malaysia

LUCIA C. VON REUSNER

Under the supervision of Dr. James P. Lassoie and Dr. Steven A. Wolf
Department of Natural Resources

Economic globalization provides civil society with the opportunity to export social movements down transnational corporate supply chains into developing nations as a means of influencing practices in those nations. Through their private contracting agreements, transnational corporations (TNCs) have significant economic clout as foreign investors in determining the conditions of production among their suppliers abroad. We begin with a literature review of the role of TNCs in advancing global environmental standards to develop an analytical framework by which TNC influence in this area can be viewed as triggering governmental policy support for TNC environmental commitments. We then focus on the case of Malaysia to apply this framework to ongoing efforts at leveraging TNCs to address deforestation in this area of South East Asia, an area dubbed “the largest wood deficit in the world” (WWF). The paper pays particular attention to Malaysia’s palm oil sector because oil palm development is the primary driver of deforestation in Malaysia. Malaysia is the focus of my case study since this paper’s hypothesis explores the extent to which market dependence can be leveraged to exact higher environmental standards, and thus Malaysia’s greater degree of export-orientation is indicative of greater market dependence.

The Energy-Water Nexus: a Case Study Comparing the Impacts to Freshwater Resources by the Alberta Oil Sands Industry and the Marcellus Shale Gas Industry in the Northeastern U.S.

AMANDA I. YOUNG

Under the supervision of Dr. Rebecca L. Schneider
Department of Natural Resources

The Alberta oil sands industry and the Marcellus shale gas industry are two very influential fossil fuel- producing industries that play a large role in global oil and natural gas production. Yet, production in each of these industries poses significant risks to freshwater resources, both due to direct consumption and to the indirect impacts to freshwater ecosystems. The objective of this study was to evaluate and compare the relative impacts of these two industries on freshwater resources and the organisms that depend on them. Over 50 studies documenting these impacts were examined, and overall, it was found that the Alberta oil sands industry requires more than 5 times the amount of freshwater to produce a unit of energy than the Marcellus shale gas industry. Additionally, four

decades of Alberta oil sands development have resulted in greater cumulative impacts to freshwater resources and dependent organisms and consequently more monitoring of, and research on, these impacts has occurred. A longer history of regulatory oversight has helped reduce the impacts, particularly on river flows. In contrast, the Marcellus shale gas industry is in its infancy (<10 years of development,) and even though it consumes less freshwater, monitoring, studies and other research are still critically needed.

Expression of Downstream Targets of mTOR in Response to a Model of Maternal Undernutrition and Hypoxia

JESSICA L. GROTH

Under the supervision of Dr. Patsy M. Brannon
Division of Nutritional Sciences

The mammalian target of rapamycin (mTOR) is a key player in a signaling pathway that regulates cell growth in response to nutrients, hypoxia, and other upstream regulators. To examine the effects of nutrient restriction, hypoxia, and their possible interactive effects on placental mTOR, two experiments were carried out on immortalized human trophoblast cells. Trophoblast cells grown in nutrient replete (complete) and nutrient restricted (NR) media were harvested at 0, 24, 48, 72, and 96h and phosphorylated s6 ribosomal protein (s6rp) and eukaryotic translation initiation factor 4E-binding protein 1 (4E-BP1) protein levels were measured using Lowry assay and western analysis to assess the time point that exhibited proteins' maximal change between media types. Next, trophoblast cells were grown in complete (C) media and normoxia (Nx), C media and hypoxia (Hx), NR media and Nx, NR media and Hx and harvested at 72h, and total and phosphorylated s6rp protein levels were measured using Lowry assay and western analysis to assess mTOR's response to these conditions.

NR had a negative temporal effect on phosphorylation of s6rp and 4E-BP1. Maximal change occurred at 48h for p-s6rp and at 72h for p-4E-BP1, thus 72h was used for the final experiment. NR alone had no effect on total protein expression of s6rp under Nx or Hx, whereas Hx decreased total protein expression of s6rp in C media samples at 72h. NR alone decreased p-s6rp but Hx alone had no effect on p-s6rp at 72h. NR and Hx interacted to affect p-s6rp such that Hx reduced p-s6rp in C media but slightly increased it in NR media. The interactive effect of Hx and NR suggest that the mechanisms by which nutrients and Hx affect mTOR signaling have not been fully elucidated, and may shed light on how these two conditions contribute to placental complications such as IUGR and preeclampsia.

An Analysis of Haitian Infants' Diets and a Critical Analysis of Dietary Quality Using Nutrient Analysis, Dietary Diversity, and IYCF Guidelines

LAUREN E. WEBSTER

Under the supervision of Dr. Rebecca J. Stoltzfus
Division of Nutritional Sciences

The 2008 Lancet Series on Maternal and Child Undernutrition identifies infant feeding education with food supplementation as an effective strategy to reduce child undernutrition by improving overall nutrient intake. We assessed the impact of an intervention providing education on infant feeding practices and a lipid-based nutrient supplement (LNS) (provided at a daily ration of 65 g between 6 months and 12 months of age) on the overall dietary quality of non-breastfed HIV-

exposed uninfected infants in urban Haiti. Dietary intake data was collected in intervention (n=77) and control (n=36) infants at age 9 months using 24-hr recalls with caregivers. Diet quality was assessed using nutrient analysis (mean nutrient intake and recommended dietary allowance (RDA)), dietary diversity, and WHO Infant and Young Child Feeding (IYCF) indicators for energy, protein, fat, vitamin A, iron, and zinc. Intervention participants were significantly more likely to meet indicators for all three methods of nutritional analysis when the supplement was included, and some findings were still significant when the supplement was excluded from intervention infants' dietary analysis. Because differences in the infants' diets exist with and without the lipid-based supplementation, findings suggest that both education and supplementation improved the infant diets. Findings examining the relationship between nutrient intake and growth showed no significant relationship. With regard to indicators of infant diet adequacy, the intervention improved all the indicators assessed. Further research must be done to compare analysis methods and present evidence as to which method is most feasible and accurate in a resource poor setting.

Strategies to Enhance the Effectiveness of Bacterial Inactivation by Supercritical Carbon Dioxide

YIFAN CHENG

Under the supervision of Dr. Syed S.H. Rizvi
Department of Food Science

In this study, the role of gram negative bacteria outer membrane as a barrier to supercritical carbon dioxide (SC-CO₂) diffusion was investigated. For the SC-CO₂-based bacterial inactivation to be effective, CO₂ or HCO₃⁻ molecules have to penetrate the cell wall, enter the cytoplasm, and interfere with the vital biochemical pathways. It was hypothesized that the negatively charged functional groups (i.e. carboxyl, phosphate), which form electrostatic bonds with divalent cations such as Mg²⁺, and contribute to the stability of the lipopolysaccharides layer also becomes a barrier to SC-CO₂. Thus, the impact of divalent magnesium cations on the permeability of bacteria outer membrane was investigated. Results indicated that the inactivation of *E. coli* cells pretreated with Mg²⁺ solution and subsequently subjected to SC-CO₂ treatment was 5.2-log lower than the control. On the other hand, pretreating *E. coli* cell suspensions with EDTA and alkaline buffer solutions increased the inactivation achieved by SC-CO₂ treatment (1200 psi, 45 °C, 35 min) by 0.73 logs. In addition, the treatment geometry (i.e. surface-area-to-depth ratio, or A/d value) was found to have a significant impact on the effectiveness of SC-CO₂ treatment. Reduction of *E. coli* suspended in distilled water by SC-CO₂ treatment was augmented from 3.9-log in "narrow-thin" geometry (A/d = 3.1 mm) to 7.5-log in "shallow-fat" geometry (A/d = 43.6 mm cm); similarly *L. innocua* population treated with a geometry of A/d = 376.2 mm was found at least 7.67-log higher in log reduction than that of A/d = 3.9 mm. Finally, log reduction of *L. innocua* and *E. coli* caused by SC-CO₂ treatment was 2.3-log and 5.4-log respectively, implying that *L. innocua* might be more resistant to SC-CO₂ treatment than *E. coli* due to the difference in cell wall structures of gram positives and gram negatives. These results have established the availability of magnesium to bacteria cells as a determining factor that greatly influences the efficacy of SC-CO₂ treatment, and provide unique insight into the role of outer membrane in gram negative bacteria as an effective barrier against SC-CO₂ treatment.

Chemical and Sensory Changes during *Flambé*

CHRISTINE E. HANSEN

Under the supervision of Dr. Gavin L. Sacks
Department of Food Science

The effects of igniting spirits during food preparation (*flambé*), on flavor chemistry are poorly understood. This study had two goals: (1) to quantify ethanol and water loss during *flambé* and (2) to characterize any changes beyond ethanol concentration. Two model systems were used: i) simple system of vodka (32g ethanol) and ii) a model caramel sauce of butter (50 g), sugar (100 g), and vodka (68 g water and 32 g ethanol). Two treatments of each system were prepared: i) ignition for 15 seconds to simulate *flambé*, ii) heating for 15 seconds without ignition. The ethanol concentration

was determined by either densimetry or GC-FID. Simple samples ignited for 15 seconds and heated for 15 seconds showed ethanol loss values of 11.1 grams (n=7) and 7.9 grams (n=4, p=.02) respectively. Less ethanol loss was observed in the model caramel sauce, and no significant difference was observed as a result of the ignition (ignited, 4.5 grams (n=4) and heated, 4.2 grams, n=4). Maximum surface and flame temperatures were also measured for simple samples ignited 15, 45, 60, and 75 seconds using two temperature probes. Surface temperatures (~75°C) never exceeded temperatures typically required for Maillard browning reactions. For sensory analyses of the simple system, untrained panelists (n=34) were asked to distinguish between ignited, heated, and control samples in a triangle test. Panelists were able to distinguish the ignited samples from either the control or the heated-only samples (p<.001). For sensory analyses of the caramel sauce system, untrained panelists (n=33) were asked to distinguish between ignited and heated samples in a triangle test. Panelists were able to discriminate between one ignited and two heated samples (p=.016). Finally, a colorimeter was used to determine differences in Hunter L-values between heated and ignited samples of the caramel sauce system. The mean Hunter L-value for the ignited and heated samples was 29.7 (n=6) and 28.2 (n=6) respectively.

Evaluation of the Storm Cell Identification and Tracking Algorithm used by the WSR-88D

ALEXANDER S. LANPHER

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

The Storm Cell Identification and Tracking (SCIT) algorithm used by the WSR-88D radar identifies storm cells and projects their future movements. It can be extremely useful in making short-term predictions about the impact that a thunderstorm may have on a localized area, allowing people to prepare for an approaching storm. In order to assess the accuracy of the Storm Prediction Forecast algorithm within the SCIT, 48 storms in New York and 24 storms in Kansas were chosen and the error between their forecast tracks and their actual paths was determined. These regions were chosen to look for any significant differences in algorithm performance in two disparate geographical regions and to include a region of the U.S. for which the SCIT algorithm has not been previously evaluated. The storms were chosen based on their severity, all being tornadic at some point during their lifespan. The Storm Position Forecast algorithm acts to predict positions for an identified cell in 15-minute intervals, out to a maximum of 60 minutes. To verify that the algorithm improves with time with respect to a given storm cell, successive scans were also analyzed to verify an improvement in the forecast tracks. Once the errors for each position forecast were calculated, comparisons were done between several different parameters to search for correlations with the errors, including distance to the radar station, dBZ value, lead-time, year and time of day. The errors were broken down further based on direction - where a storm went versus its projection. The most outstanding result discovered was in the separation of error into individual directions. For both the New York and Kansas storms, there was a prominent trend for the storm's actual path to be to the right of the projected path. The reason for this preferential rightward error can only be hypothesized here and would be an area for further research.

Effect of Turbidity and Membrane Pore Size on Cross-flow Microfiltration of Apple Cider

EVONNE LAU

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

Microfiltration (MF) is a membrane separation process but its main limitation is membrane fouling. In case of apple cider MF, suspended solids (plant cell wall materials, proteins, and polyphenols) are the main contributors to fouling. In this study, the effect of turbidity, an indicator suspended solids quantity, and the membrane pore size on the flux in MF of apple cider was investigated. Raw apple cider experiments ran in a pilot-plant scale MF unit equipped with ceramic membranes of 1.4 μm , 0.8 μm , and 0.45 μm pore sizes, varying turbidity levels, at 6°C, 5m/s crossflow velocity and 159 kPa transmembrane pressure. The permeate flux measured MF efficiency; physical-chemical properties of the cider and microfiltered juice evaluated product quality. Significant changes in pH, °Brix and viscosity were observed only for cider microfiltered with 0.45 μm . At high turbidity, the 1.4 μm and 0.8 μm membranes resulted in similar permeate final flux (65L/m²h), relative flux decline of 72%; while 0.45 μm had the lowest final flux (37L/m²h), relative flux decline of 55%. At low turbidity, 1.4 μm , 0.8 μm , and 0.45 μm resulted in comparable final fluxes (49, 52, 53L/m²h, respectively) and relative flux decline of 61%, 64%, 55%, respectively. The smallest pore size resulted in the highest rejection of particles and lowest flux, but the lowest flux decline; while the largest pore size had a higher flux, but more pronounced flux decay. This suggests that the fouling layer differs at different pore sizes. Thus, membrane pore size and pre-filtration are critical for MF efficiency and can optimize this process for commercial applications.

Classifying Causes of River Flooding in Upstate NY and Predicting Future Flooding Patterns with Global Climate Change

MEAGAN E. MNICH

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

The Capital Region of New York lies at the junction of two of New York State's major rivers: the Hudson River and the Mohawk River, leaving it vulnerable to flooding. Shifting precipitation patterns in the area as a result of global climate change have been speculated to increase the severity and/or frequency of flooding. The purpose of this investigation is threefold, one, to identify the historical high discharge events on the Hudson and Mohawk Rivers while assessing trends, two, to determine causation of the events, and three, to apply the standards developed for causation to climate models and address the possibility of future changes in flooding patterns. This was achieved by determining the largest discharge events on the rivers, classifying them based on discharge and season, investigating the causes by examining at weather data from 4 different stations around the watershed, and averaging these precipitation and snowmelt values to establish thresholds associated

with the highest discharges. These thresholds were applied in the historical record to determine how frequently these weather conditions occurred but did not result in flooding. Data from the GCM GFDL (Global Climate Model of the Geophysical Fluid Dynamics Laboratory) model under two scenarios was utilized to determine the future flooding frequency and severity in the region. It was found that recommendations are difficult to make because of the large amounts of variables in the system, but there is a correlation between projected global climatic changes and flooding events in this region, particularly the Mohawk River basin.

Common Beans Cooked at High Altitudes Have Higher Trypsin Inhibitor Activity and Lower Protein Digestibility than Beans Cooked at Sea Level

CLAUDIA M. PAZLOPEZ

Under the supervision of Dr. Dennis D. Miller
Department of Food Science

Legumes are high in protein but also contain heat labile trypsin inhibitors (TI's) that reduce protein digestibility. To test if cooking at high altitudes is less effective at inactivating TI than cooking at sea level, common beans and fava beans were cooked in water at temperatures chosen to simulate boiling points at different altitudes. In addition, each variety was autoclaved in water at 121°C to simulate a pressure cooker. Trypsin inhibitor activity (TIA) was measured with N- α -Benzoyl-L-arginine 4-nitroanilide hydrochloride, and *in vitro* protein digestibility was determined by digestion of samples with 3 peptidases. Raw common and raw fava beans inhibited 100% and 36% of trypsin activity, respectively. Cooking common beans at 100°C inactivated 88.6% (SD \pm 4.8) of TI, while cooking at temperatures between 87-97°C inactivated 73.2% (p <0.05). In fava beans, TI inactivation was 75% at all cooking temperatures. TI inactivation in an autoclave was positively correlated with time for common beans (p <0.05) but not fava beans. Protein digestibility in common beans was 79.1% in raw beans, 85.0% in beans cooked at 87°C and 89.7% in beans cooked at 100°C. Fava bean digestibility was greater than that of common beans when raw (86.0%) and when cooked at 100°C (95.6%). Regression analysis showed a negative correlation between TIA and protein digestibility ($r^2=0.86$). Residual TIA of common beans cooked at high altitudes in boiling water is higher than when cooked at sea level, lowering protein digestibility. In populations where protein intakes are marginal, this could negatively impact protein nutritional status.

Strong Solar Storms and their Effects on Middle and Lower Stratospheric Ozone Concentrations

JOSHUA M. PETTIT

Under the supervision of Dr. David L. Hysell
Department of Earth and Atmospheric Sciences

Solar Storms are a well-known disruptor of the upper atmosphere. Radio communication as well as the safety of space travelers and equipment is at the mercy of these storms. Despite this, little work

has been done in showing what these storms due to lower levels in the atmosphere. In this paper I look at strong solar storms and see how they affect the ozone concentration at 50mb, 20mb, and 10mb levels. Using daily ozone data and satellite instrumentation for solar events, I looked at how ozone changes during and after these events. I found that solar flares have the largest impact with concentration changes as high as 80%. Solar wind events seemed to only have modest impacts followed by coronal mass ejections which appear to have little impact at all.

The Effects of Low-Frequency Climate Oscillations on Interannual Variations in East Coast Winter Storm Tracks

SETH F. SASLO

Under the supervision of Dr. Gang Chen
Department of Earth and Atmospheric Sciences

Correlations between low-frequency climate oscillations and East Coast Winter Storm location are explored using the Hirsch et al. (2001) definition of ECWS and NCEP Reanalysis data. Relevant climatic factors are identified, and comparisons are drawn in ECWS geographic frequency between significant positive and negative phases of these climate oscillations through an automated procedure. It is found that the Multivariate ENSO Index, the North Atlantic Oscillation, the Arctic Oscillation, and the Pacific Decadal Oscillation are significantly correlated to ECWS frequency at specified grid points along the East Coast. Furthermore, it is apparent that select modes of these climate oscillations have a more profound effect on ECWS frequency than others: A positive ENSO keeps storms on a more southerly route; A negative NAO and AO confine storms to the mid- and north coast; and a negative PDO moves storms to the north. Maps of average 500 mb heights during these storm days are created and sorted by sign and magnitude of climate index, and aid to an explanation of storm motion through temperature and height gradients as well as trough axis position.

Arabidopsis Salicylic Acid-Binding Metalloendopeptidases TOP1 and TOP2 Regulate H₂O₂ Accumulation and Programmed Cell Death during the Immune Response against the Bacterial Pathogen *Pseudomonas syringae*

GIULIO ZAMPOGNA

Under the supervision of Dr. Sorina C. Popescu
Boyce Thompson Institute for Plant Research

Salicylic acid is a phytohormone indispensable for plant immunity. Interactions between hosts and pathogens create selective pressures—a cycle whereby hosts evolve novel defenses and alarm systems while their pathogen counterparts evolve enhanced weaponry and stealth tactics. Not uncommonly, plants lose the war against pathogens and succumb to disease. If a plant does survive a pathogen attack, it may be left with battle scars that reduce vegetative growth and fruit yield and quality. Without question, human survival depends on the abilities of plants to defend themselves against and survive pathogen onslaughts. With an increased understanding of plant immunity, humans will gain the ability to modulate and augment plant defenses to minimize disease and yield losses. *Arabidopsis thaliana* thimet oligopeptidase (TOP) family TOP1 and TOP2 metalloendopeptidases bind salicylic acid and may, therefore, play critical roles in plant immunity. Our research demonstrates that TOP1 and TOP2 regulate hydrogen peroxide accumulation, programmed cell death intensity, and possibly chloroplast integrity during the hypersensitive response following infection by the hemibiotrophic bacterial pathogen *Pseudomonas syringae*. We hypothesize that TOP1 and TOP2 are central hubs in reactive oxygen species production and redox regulation, and, as such, may influence physiological responses during both abiotic and biotic stresses.

“Going to a Bathhouse to Meet Friends”: An Exploratory Study of Grindr, a Social Networking Application for Gay and Bisexual Men

CHARLES B. ABBOTT

Under the supervision of Dr. Jeremy P. Birnholtz
Department of Communication

This study explored the usage and implications of Grindr, a smartphone social networking application for men who have sex with men. Online spaces are important for both interacting with others and for allowing for self-presentation opportunities that differ from real life. Previous literature on self-presentation and interaction online has focused on chat rooms, dating sites and “traditional” social media sites; Grindr is distinct from these in that there is the ability to see any user nearby, as well as having limited opportunities for self-presentation. This thesis seeks to understand how users self-present and interact with one another on the application in the context of what they use it for. In this study, 14 participants were interviewed about their usage of the application. Analysis of the transcripts revealed that Grindr acts as a multipurpose tool that is used for social interactions both on and off the site, as well as to facilitate in-person sexual interactions. Users reported placing a high significance on visual information (i.e. profile pictures) for both self-presentation and forming impressions of others, indicating that many users with primarily social motives are nonetheless concerned with others' perceptions of their appearance. Further research is necessary to see how usage changes on environment (e.g. in cities), and also why visual self-presentation on the application appears to deviate from previous findings.

An Exploration of Perceived Performance, and Its Importance to Software

ANNIE Y. BAI

Under the supervision of Dr. Geri K. Gay and Dr. Eric P.S. Baumer
Department of Communication and Department of Information Science

Perceived performance measures the performance of software in the eyes of its users. Both traditional performance and existing literature on perceived performance stress time as the main metric of performance. However, time does not paint the entire picture. From this study, four prominent themes that affect perceived performance emerged: time, expectations, reliability, and goal-centricity. In addition to time, the latter three themes also play a large role in dictating the user's perception of software performance, and thus should also be emphasized in the software design process. In addition, aggregate user responses revealed three groups of software for which perceived performance was crucial: everyday software, specialized software, and software for work.

Although traditional performance has been the prominent indicator of whether or not software is ready to be released, perceived performance plays an increasingly significant role in the way software will be received as software for individual consumers gains importance.

Psychopaths Online: Modeling Psychopathy in Social Media Discourse

RACHEL C. BOOCHEVER

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

This is an exploratory study examining the relationship between discourse patterns in social media and undergraduate students' levels of psychopathy when compared to discourse patterns in narratives produced in a laboratory. It expands on previous research findings that psychopathic murderers exhibit narcissistic tendencies and psychological distancing in their discourse when compared to non-psychopathic murderers. Undergraduate students' emails, SMS messages, and Facebook messages were collected and analyzed in relation to their scores on the Self-Report Psychopathy Test III (SRP III). Findings support both main hypotheses: that discourse patterns in social media are distinctly different from discourse patterns in narratives produced in a laboratory, and that psychopathic tendencies are identifiable in social media discourse. Consistent with previous studies, students higher in psychopathy showed evidence of psychological distancing, produced less comprehensible language, potentially reflecting their low reading achievement levels, and produced more anger and swear words, consistent with the emotional deficits and disagreeableness central to psychopathy.

An Analysis of How Dairy Farmers Divide Their Time Among Twelve Key Management Areas and Farm Profitability

CAROLYN M. BRAUN

Under the supervision of Dr. Wayne A. Knoblauch
Charles H. Dyson School of Applied Economics and Management

The relationship between the time dairy farm managers spent on twelve key management areas and dairy farm financial performance was analyzed. The twelve key management areas analyzed were (1) milk quality, (2) milk quantity, (3) reproduction, (4) cow comfort, (5) nutrition, (6) reducing the incidence of metabolic disorders, (7) dry cow comfort, (8) calf management, (9) financial records, (10) financial management (11) crop production and (12) human resources management. Studies in the past have analyzed the factors that affect farm financial performance. However, these studies have never looked at the breakdown of manager hours spent on the factors and how that affects profitability. A multiple regression analysis was performed using a best subsets regression to determine the variables to include in the model. A $p\text{-value} < 0.05$ was considered significant. The time managers spend on milk quality, milk quantity, reducing the incidence of metabolic disorders and financial management had a negative relationship with net farm income without appreciation. Time spent on cow comfort, nutrition, dry cow comfort, calf management, financial records and human resources management had a positive impact on net farm income without appreciation. In this study, time spent on reproduction and crop production was not statistically significant and therefore not included in the final model. The results of this study will help dairy farm managers structure the

areas they focus on in order to improve farm efficiency which will in turn lead to an increase in financial performance for the farm.

What's Religion got to do with it? Islam and Fertility in Senegal and Cameroon

ALYSSA R. BROWNE

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

Religion has been proven to influence a wide range of individual outcomes, including gender-specific health experiences such as fertility. This study examines the role of religion in women's decision-making, both broadly and with a special focus on reproductive decisions. Quantitative analysis of Cameroon (2004) and Senegal's (2005) Demographic Health Surveys is combined with information from qualitative focus group discussions that were held in each country in 2011. These analyses were used to investigate 1) whether Muslim women have the same level of control over household decision-making as their non-Muslim counterparts; 2) whether the extent of Muslim women's participation in key household decision-making differ from their participation in reproductive decisions; 3) whether rates of contraceptive use and participation in reproductive decision-making differ between Muslims and non-Muslims; and 4) how Muslim women and men view the influences and prescriptions of religion on the practice of family planning. Cameroon and Senegal serve as fruitful locals to investigate these questions, as the former represents a more pluralistic society while the latter is predominantly Muslim. Findings suggest that religion continues to mediate women's relative control in different arenas of household decision-making, including family planning. Given international concern over achieving reproductive health, crystallized in Millennium Development Goal 5, future interventions will need to be sensitive to the role of religion.

Can a Text Message Influence our Perceptions of the Physical World?: Text Messaging as a Prime for Social Support

ANGELA L. FALISI

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

Previous research has found that a psychosocial resource, social support, affects a person's perception of physical burdens, particularly the steepness of geographical slants. In fact, there is a decrease in the perceived steepness of a geographical slant when a person is in the physical co-presence of another person or after an extended period of visualization of a supportive other. The present study replicated and extended previous findings to test whether the brief activation of a supportive other by sending a text message to them affects subsequent judgments of a geographical slant. Participants who sent a text message to a friend judged a hill to be less steep than did those who were in the physical co-presence of a friend. Even after controlling for relationship duration and

strength, a media effect remained. This suggests that a text message serves as a purer prime to activate the idea of a supportive other, which includes the qualities that are most relevant to the task at hand. In comparison, the prime of a physically co-present friend may elicit a broader array of qualities that might or might not be useful to the task at hand, thus diluting the effectiveness of the prime overall.

Examining Conceptions of Singledom among Older Ever-Singles

KIMBERLY MCERLEAN

Under the supervision of Dr. Lee Humphreys
Department of Communication

With an aging population, the host of alternatives to marriage, and the number of people who remain single, ever-single older adults are an important group to understand and their responses can be valuable in helping senior living communities and others work with and provide for this segment of the population. This article draws from interviews with 12 ever-single men and women between the ages of 65 and 87 to explore their changing perspectives of themselves as ever-single, the positives and negatives they perceive with their status, and the social norms surrounding relationships. Many of the participants saw their singlehood as a process and something that opened up opportunities for them that might not have been possible had they been married. Singlehood was seen as having both upsides—such as independence—and downsides—such as lack of companionship—but all participants expressed happiness with the way their lives had turned out. While many participants indicated that marriage was an expectation in the times that they were growing up and that remaining single used to be stigmatized, almost all respondents suggested that society was moving towards acceptance of alternative lifestyles to marriage. The responses from the interviewees illustrate the process involved with being and becoming a single adult.

Links and Lies: The Effect of Warrants on Professional Self-presentation in LinkedIn Profiles

KATE E. PASCUCCI

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

This study examines how the links to LinkedIn profiles affect patterns of deception during self-presentation. Deceptions are produced during self-presentation to appear attractive or competent. The connections created in LinkedIn profiles create a unique environment in which the self-presented resume is made public to an entire network of friends and colleagues. This combination of a desire to appear favorably combined with the fact that the information is now public and available to known others was expected to affect the strategic use of deception in self-presentation. Participants ($n=30$) were asked to analyze the relationship between resume deceptions and various link characteristics, including 1) link status, 2) link closeness, 3) the ability of the link to detect the

resume deceptions, and 4) the degree the participant would be concerned that the link detected the deceptions. Contrary to expectations, the results revealed that, while LinkedIn connections raised concern about deception detection, the more participants felt that their links could detect their lie, the more deceptions they produced in their resume. Participant comments indicate that many participants were surprised by their own deceptions in the face of links that could detect them. The results are discussed in terms of warranting theory and the novel concept of warranted self-presentation.

Risk Perception, Uncertainty, and Trust: The Case of Artificial Sweeteners

ESTI L. ROSS

Under the supervision of Dr. Clifford W. Scherer
Department of Communication

Background. The use of artificial sweeteners is at an all time high. Yet, there is controversy about possible health effects of the use of such sweeteners. Interpreting the health risks associated with artificial sweeteners is a difficult challenge because the risks are indefinite and controversial. Prior research indicates that there is a great degree of variability in scientific findings about the side effects of artificial sweetener consumption. This study investigated the complexity of risk ambiguity and explored how artificial sweetener users and non-artificial sweetener users perceive artificial sweetener risks, trust in different sources, risk optimism, and important factors contributing to their use on a personal level. *Methods.* An online survey was distributed to female undergraduate women to assess whether they consumed artificial sweeteners as well as to understand their perceptions of the risks of artificial sweetener use. *Results.* Artificial sweetener users perceived fewer risks associated with artificial sweetener use than non-artificial sweetener users. Artificial sweetener users are less likely to trust science sources and are significantly more likely to trust government-sponsored websites and industry-sponsored websites than their non-artificial sweetener counterparts. Optimistic bias was largely observed among artificial sweetener users. The greatest motivating factor for consuming artificial sweeteners was the desire for weight loss and/or to maintain weight. *Conclusion.* There are critical cognitive differences between those that consume artificial sweeteners and those whom don't in regards to how they perceive the risks and behave as a result. By understanding the interaction of critical factors such as social trust, risk optimism, and risk uncertainty among artificial sweetener users, society can adapt present education mechanisms and regulations to optimize awareness, trust in institutions, and proper behavior.

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