The W. M. Keck Center for Behavioral Biology Welcomes its New Faculty

Kurt Marsden

As we enter the new academic year, the W. M. Keck Center for Behavioral Biology welcomes its two new members. Kurt Marsden has joined the Department of Biological Sciences as an Assistant Professor. Marsden seeks to understand how the brain controls behavior. For example, how do animals decide whether to respond to a stimulus? How does experience enable them to learn to modify their responses? And how are these processes disrupted by environmental insults or diseases such as anxiety and autism? Using the zebrafish as a model system, Marsden employs high-throughput behavioral testing, pharmacology, genetic manipulation and analysis, and 3D imaging of neural circuit development and activity to define how genes guide the formation and function of neural circuits that drive specific behaviors. Furthermore, by modeling aspects of conditions like autism in a simple vertebrate system Marsden hopes to better understand the biological basis of neurobehavioral disorders and reveal avenues for potential therapeutic intervention.

Albert Keung

Albert Keung is an Assistant Professor in the Department of Biochemical and Biomolecular Engineering. His laboratory develops new synthetic biology approaches to address pressing human needs. The Keung laboratory engineers molecular tools to study and intervene in diseases, harness stem cells for biomedical therapies and unravel disease mechanisms, and designing next generation biological circuits for use in cell-based biotechnology. Chromatin confers unique regulatory properties not accessible through traditional genetic engineering that could be useful in biotechnology. Keung explores the diverse ways by which chromatin enables cells to “compute”. His team uses DNA-targeting technologies to edit chromatin properties to more efficiently engineer cells and elucidate disease mechanisms, with a special interest in neurodevelopmental disorders and addiction.

“The addition of these two brilliant young investigators considerably expands the scope of the Keck Center”, says Center Director Robert Anholt, “I am delighted to have them on board.

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Love and Brains in Prairie Voles

by Sneha Mokashi

On August 9th, 2017, Andrea Vogel of the McGraw laboratory successfully defended her doctoral thesis entitled “Environmental plasticity of pair bonding in the monogamous prairie vole”.

Andrea began her talk by indicating the significance of social behavior with respect to organismal fitness. The social behavior her thesis focuses on – monogamy - has its pros and cons. The advantage of guaranteed offspring is offset by the fact that having just one partner leads to a loss of heterozygosity in the population over time. Less than 5 percent of mammals are monogamous, which leads to the choice of an unusual model organism - the prairie vole. Prairie voles are “socially monogamous”. They show biparental care, mate guarding and partner preference in terms of pair bonding, but some may ‘cheat’.

Andrea tested five hypotheses for her dissertation based on the literature and accepted dogmas in the field.

First, she tested the hypothesis that there is variation in pair bonding behavior, but that most are socially monogamous. To test this hypothesis she performed several behavioral assays. When males were given a choice between a stranger and the partner female she observed a lot more variation in partner preference than expected. Variation was also observed in anxiety related behaviors tested by the well-established open field test.

Second, she assessed whether this variation has a genetic basis and is heritable. In order to test this Andrea looked at the relationships between individuals tested in the behavioral experiments, which all belong to the same colony. The number of tested individuals was not enough to determine trait heritability. To overcome this limitation, Andrea looked at the pedigree of the entire colony in collaboration with the Maltecca lab to understand the genetic relationships between the tested individuals in more detail. From this analysis, she determined that the narrow sense heritability of partner preference is not significantly different from zero and concluded that partner preference is an environmentally plastic trait. Which environments lead to differences in partner preference behavior is a topic for future study.

Third, Andrea asked to what extent social behaviors change after mating. She tested the effect of mating on anxiety, alloparental care and aggression by performing these behavioral assays both pre- and post-mating. No significant difference was observed in anxiety and alloparental care. Licking and grooming of pups decreased after mating. Only aggressive behavior towards the same sex (in males) increased after mating. This was tested using the well-established resident-intruder assay.

Fourth, Andrea asked to what extent partner preference has correlated social behaviors.

Finally, Andrea tested the expectation that vasopressin receptor density is correlated with partner preference behavior. Several regions of the brain form the social brain network. For her study, Andrea focused on the ventral pallidum and retrosplenial cortex since these regions have been implicated in pair bonding by previous studies. Andrea used autoradiography to visualize the vasopressin receptor density in these tissues, indicated by ligand binding. Brains were harvested after behavioral experiments in order to get both behavioral and vasopressin receptor density data from the same individuals. She observed that vasopressin receptor density was not correlated with partner preference behavior but was correlated with affiliative behavior, which is one component of pair bonding.

Thus, Andrea’s study changes current perceptions about pair bonding behavior. It was thought that all prairie voles are socially monogamous but Andrea shows that this is not true for all. Secondly, Andrea’s study negates the idea that pair bonding is a significantly heritable trait. It is, in fact, highly environmentally plastic. Finally, vasopressin was thought to be the main neurotransmitter involved in pair bonding, but Andrea finds that it is, in fact, just one component of a complex unknown mechanism.

Several studies can be performed in the future based on Andrea’s work. The roles of different environments and other neurotransmitters such as oxytocin and dopamine remain to be tested. This study was performed on monogamous voles. It would be interesting to observe whether polygamous voles show similar variation, with some of them being monogamous.
This summer, Evolution 2017 was held in Portland, Oregon, the joint meeting between The American Society of Naturalists (ASN), Society of Systematic Biologists (SSB), and Society for the Study of Evolution (SSE). Over the 5-day span of the conference, over 1700 attendees shared in presenting their findings in talks, posters, all falling under the common, yet broad theme of evolution. With so many attendees and lots of topics to cover, the conference was set up to maximize communication with multiple 15 minute talks being presented during the morning and afternoon sessions, with 3 poster sessions held during the evenings of the conference. Many talks were also recorded and uploaded to the conference’s YouTube channel.

The W. M. Keck Center for Behavioral Biology at NC State was well represented at Evolution, with a talk by Ashley Elias, a postdoc in the Robert’s lab, who spoke about phenotypic versus genotypic sex: characterization of multiple loci in a complex sex determination system. Emily Moore, a recent graduate of the NCSU Genetics Program, and current postdoc, presented a poster on “Genetic variation at a CNE correlates with microhabitat-associated behavioral differentiation in Malawi African cichlid fishes,” alongside current graduate student, Erin Peterson, who presented a poster titled “Polygenic Sex Determination in Astatotilapia burtoni.”

These opportunities allowed us to not only garner feedback on our own techniques and findings, but also facilitated stronger partnership in research as we were able to meet with collaborators, Astrid Boehne and Athimed El Taher, a post-doc and graduate student who work in the Salzburger Lab at the University of Basel, in Switzerland. Astrid’s talk “Sex determination in East African cichlid fishes: limited options or space for novelty?” focused on their efforts to understand the different forms of genetic sex determination in the cichlids of Lake Tanganyika. Using whole genome sequencing and transcriptomics, they aim to both map and identify the genes that work in sex determination.

Many talks addressed the evolution of adaptive traits by examining gene expression in relevant tissues. One such talk came from Mark Nolte of Bret Payseur’s lab at the University of Wisconsin-Madison. His work aims to understand metabolic shifts that accompany island gigantism, and compares differential RNA expression between island and mainland mice to the QTL mapping results from the hybrid cross between the two populations. This allows for systems-level analysis in an evolutionary model, at a lower cost than a traditional eQTL approach.

One talk of interest to both phylogeneticists and population geneticists came from Jeet Sukumaran of the University of Michigan. His well-attended and lively talk, entitled “Species Delimitation under the Multispecies Coalescent: Confusing Populations with Species in the Grey Zone,” was a plea to use the multispecies coalescent responsibly. The more genetic data you enter into the model (such as is possible with high-throughput sequencing projects), the more sub-groups can be found. However, the biological interpretation of species is up to the researcher, not the model.

Particularly of note were the presidential addresses for the American Society of Naturalists and the Society for the Study of Evolution. Kathleen Donohue’s address marked the 150th anniversary of the society, and reflected on the past while looking towards the future. She outlined an important role for naturalists in the light of a planet that is increasingly modified by humans. In the presidential address for SSE, Sally Otto spoke to the true theme of the conference, reflecting on genetic conflicts present between individuals and groups throughout evolution. Evolution 2017 was a wonderful chance for meeting colleagues and experience the depth and breadth of evolutionary biology across the nation and the world.
Seminars

On September 14, 3:30 pm, Dr. Howard Fields from the Center for Integrative Neuroscience at the University of California at San Francisco will present a seminar, titled “Mechanisms of opioid reward and analgesia”.

On September 18, 1:30 pm, Dr. Daniel Weinberger from the Lieber Institute for Brain Development and the Solomon H. Snyder Department of Neuroscience at the Johns Hopkins University will present a seminar, titled “Genomic insights into developmental origins of schizophrenia”.

All seminars will be in 3503 Thomas Hall.

Grants

John Godwin together with investigators at Texas A&M University, University of Adelaide, CSIRO in Australia, the USDA National Wildlife Research Center, and the NGO Island Conservation received a two year $3,200,000 grant from DARPA to study restoring ecosystems and biodiversity through development of safe and effective gene drive technologies. A two-year $3.2 million extension is optional, pending progress.

Heather Patisaul received a five-year $2,210,410 grant from the National Institute of Environmental Health Sciences to study the placenta as a novel target of sex specific neurotoxicity by fire retardants.

Heather Patisaul received a three-year $564,935 Idea Development Award from the Department of Defense Autism Research Program to study environmental contaminants and autism risk.

Publications

The following publications of the W. M. Keck Center for Behavioral Biology have appeared in print:


Of note…

Sheryl Arambula participate in the Summer Program in Neuroscience, Excellence and Success (SPINES) at the Marine Biological Laboratory of the University of Chicago.

Fred Gould gave the keynote address at the 14th International Symposium on the Biosafety of Genetically Modified Organisms in Guadalajara, Mexico on “Environmental effects of GM crops: Findings of a National Academies of Sciences, Engineering and Medicine (US-NASEM) report.” He also served on the planning committee of the International Academies Workshop on Assessing the Security Implications of Genome Editing Technology.

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