

The Signal

Monthly newsletter of the W. M. Keck Center for Behavioral Biology
at North Carolina State University
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Sixteen and Still Going Strong

The 16th Annual Student/Postdoc Symposium of the W. M. Keck Center for Behavioral Biology showcased the impressive breadth and diversity of the Center's research activities with the largest number of oral and poster presentations to date, representing 16 different laboratories and reflecting the Center's steady growth and unwavering enthusiasm of its students and postdocs. Once again, we were pleased to host representatives from the Center for the Integrative Study of Animal Behavior at Indiana University, Robert Bowers and Delia Shelton, who gave excellent presentations.

The Center has benefitted greatly from both corporate and private donations, including the John and Barbara

Vandenbergh Travel Awards and the Robert and Margaret Grossfeld Award.

The Grossfeld Award is awarded annually to the student or postdoc who published the most creative and influential peer reviewed article during the preceding year. This year's recipient was Justa Heinen-Kay for her work on the effect of human induced habitat fragmentation on evolution of sexual selection in an ecologically tractable model system, Bahamian mosquitofish. Justa's doctoral dissertation is under the guidance of Dr. Brian Langerhans

For a detailed description of this year's symposium see the article by Gabriel Zilnik and Tiffany Garbutt on page 3.



Justa Heinen-Kay (center) receives the Grossfeld Award from Dr. Robert Grossfeld. On Justa's left, Center Director, Dr. Robert Anholt, on the far left and far right, Keck Center Executive committee members, Drs. Fred Gould and Coby Schal. Also present (not pictured) were Drs. Trudy Mackay and John Godwin, Chair of the Grossfeld Award committee.

Keck Center Scientists Receive Holladay Medal



William Neal Reynolds Distinguished University Professor Trudy Mackay and Blanton J. Whitmire Professor Coby Schal have both been announced as the 2015 recipients of the prestigious Alexander Quarles Holladay Medal for Excellence. Both Mackay and Schal are founding members of the W. M. Keck Center for Behavioral Biology. The Holladay Medal is the highest award made by the University in recognition of faculty achievement and in recognition of the achievements and contributions of a faculty career at North Carolina State University. The award consists of a medal and a framed certificate presented at Spring Commencement. In addition, a permanent plaque is inscribed with the recipients' names and displayed in the Faculty Senate Room. "The Holladay Medal is a

well-deserved honor for both Trudy Mackay and Coby Schal and bears testimony to the academic excellence of our organization", says Keck Center Director Robert Anholt,

The Holladay medal was established to commemorate the contributions to the University of Alexander Q. Holladay, who served as its first Professor of History and its first President. The award recognizes members of the faculty who over their careers have made outstanding contributions to the University through their achievements in research, teaching, or extension and engagement.

Other Keck Center recipients of the Holladay Medal are Dr. John Vandenberg in 2002 and Fred Gould in 2011.

The W. M. Keck Center for Behavioral Biology Announces

The Second Annual Brain Awareness Week Event at the Nature Research Center of the North Carolina Museum of Natural Sciences

March 12, 2015

From flies to humans and every animal in between, brains make behavior happen.

From 6-7 pm, meet local neuroscientists and interact with hands-on brains and behavior exhibits suitable for all ages. Short, accessible talks by NCSU scientists in the Daily Planet will celebrate National Brain Awareness Week and tell you what local neuroscientists are discovering.

At 7 pm, our special guest, prominent neuroscientist Dr. Baldomero Olivera from the University of Utah will lead a Science Café presentation entitled "From Deadly Venomous Cone Snails to Drugs for Pain."

16th Annual W. M. Keck Center Symposium

by Gabriel Zilnik & Tiffany Garbutt



On February 20, 2015 with the mercury dipping below freezing, students, postdocs, faculty, and staff gathered to begin the 16th annual symposium of the W.M. Keck Center for Behavioral Biology. After breakfast the field of two dozen students and postdoctoral researchers began the event with an introduction from Robert Anholt, the director of the Keck Center. According to Anholt, this year had the largest number of submitted oral and poster presentations at twenty-six. True to its mission, research within the Keck Center covered a broad range of topics: from African cichlids to trap-jaw ants, observational to molecular analysis.

In a first for the event, highlights of the presentations were tweeted under the hashtags #NCSU and #KeckBehavior. Each presenter had fascinating insights. However, due to the large number of presentations this year, here are highlights from a few select talks.

Melissa Lamm gave a presentation on gene expression in a sex changing fish, the bluehead wrasse (*Thalassoma bifasciatum*). Her work incorporated sophomores from the undergraduate research program PackTrack. Lamm and her undergraduates developed *in situ* hybridization assays for nearly a dozen genes known to have a role in vertebrate reproduction, sexual behavior, and aggression or some combination of the three.

One of the center's postdoctoral scholars, Clint Pennick, talked about food waste. Some back of the envelope calculations show that city-dwelling humans produce nearly 250 million metric tons of food waste yearly. Interestingly enough, urban ants may process some of that waste. Pennick and collaborators investigated pavement ants, *Tetramorium* sp., with stable isotope analyses. Ants in highly urbanized environments -sidewalks and street medians in New York City- diverge in the isotope profiles from ants

found in parks. As it turns out, the carbon isotope profiles of highly urbanized ants are incredibly similar to human fast foods! This could have big implications for us and the species we share our cities with.

The morning session ended with the Robert and Margaret Grossfeld Award Presentation and Lecture by the award winning student Justa Heinen-Kay. Justa's research, under the direction of Brian Langerhans, approaches the question of adaptation in human caused habitat fragmentation. She uses members of the *Gambusia* genus of mosquitofish as her experimental system. The specific fish studied inhabit Bahamian tidal creeks across six islands. In the most extreme cases of man-made disturbance creeks were partially filled and cut off from the ocean flow. Heinen-Kay provided ecological consequences of fragmentation: reductions in predation and salinity, and an increase in conspecific fish. Consequently, her and her collaborators found male genitalia underwent rapid and predictable divergence. They believe their findings might broadly apply to species also undergoing anthropogenic habitat fragmentation, but further research is needed.

The afternoon talks proved to be an exciting arrangement of topics including wild anxious mice, benzaldehyde adverse and age variable flies, frisky voles, insecticide resistant cockroaches, elevation climbing ants, pheromone covered moths, and pesky disease causing ticks! Here are some highlights from the afternoon sessions.

Robert Bowers, one of the visiting scholars from Indiana University, talked about contrasting theoretical frameworks that might explain how rats use what they learn about cause and effect to perceive their environment. Bowers explained that neither causal reasoning, the ability to identify causality, nor associative learning, the process in which a response becomes associated with a system, is sufficient to

explain the complexity of behavioral variables necessary for causal cognition and behavior in rats. Instead, Bowers' research proposes a behavioral systems approach that produces a finer measurement of multiple feeding-related behaviors that neither causal nor associative reasoning can sufficiently explain on their own. Bowers' behavioral systems approach allows for the analysis of multiple behavioral variables that can affect causal cognition, and ultimately behavior in rats.

Alison Moyer took the audience on a prehistoric journey to meet "Big Mamma" a fossilized avian dinosaur that was preserved in a position covering its nest for approximately 71 million years and serves as the first evidence of brooding. Moyer analyzed the thin white keratin material extending off the bone (the claw) of Big Mamma. They hypothesized that if the original endogenous keratinous material remains, then they should be able to detect biomaterials...and they did! Moyer and team discovered the longitudinal keratin fibers of Big Mamma's claw bore a striking similarity to the claw of a modern day emu. Furthermore, the concentrations of carbon, oxygen, and sulfur in Big Mamma's claw also resembled those of the emu. However, unlike the emu, Big Mamma's claw was 30% calcium. Moyer and team are looking forward to analyzing other samples from Big Mamma and her nest, as well as another fossilized specimen that was found approximately 10 to 15 meters away.

Xiaohu Xie discussed the importance of the role of dopamine in impulsivity. High impulsivity is often associated with susceptibility to cocaine relapse in cocaine addicts. Xie and colleagues used the delay-discounting paradigm to assess impulsivity in rats. Delay-discounting is the principle that states that an immediate award is preferred over a larger award that arrives later, because the value of the larger award diminishes with increasing time. Xie and team surgically implanted a microelectrode into the nucleus accumbens region in rats and measured the level of dopamine released during a delay-discounting test. During the test rats choose between one sucrose pellet immediately released or two sucrose pellets released after a two second delay period. Xie found that there is an individual difference in the preference between the immediate, smaller reward versus the larger delayed reward. In other words, Xie explained, some of us might prefer a single slice of pie because we do not like pie that much, versus others who love pie and would prefer a whole pie. This research could have implications for understanding neural mechanisms behind impulsivity, decision, and addiction.

A special thank you to the graduate student coordinators, Megan Serr and Caroline Leitschuh, who did a great job of organizing this year's symposium.

Joel Johnstun was awarded best oral presentation and J. E. Wong was awarded best poster presentation. Congratulations to both winners and to all who shared their research and participated in making this the best W. M. Keck Symposium to date!

Brains to Behavior: Potential Health Effects of Bisphenol A

by Sheryl Arambula



On February 27th, Meghan Rebuli, a Zoology and W. M. Keck Center for Behavioral Biology student, presented her dissertation seminar entitled "Sex Specific Impact of Environmental Endocrine Disruptors on Neuroendocrine Development and Behavior."

Endocrine disrupting compounds (EDCs) are a broad class of chemicals found in pesticides, plasticizers and plastics, industrial chemicals, and fuels that have been shown to interfere with the structure and function of endocrine system. Under the mentorship of Dr. Heather Patisaul, Meghan's research focused on how exposure to endocrine disrupting chemicals, specifically bisphenol A (BPA), can alter developmental processes and behavior in a sex specific fashion.

During fetal development, sex hormones organize the brain. Research in rodent models have shown estrogen is directly responsible for the development of many sexually dimorphic brain characteristics that are region specific and age specific. This led Meghan to question if these sex specific dimorphisms were vulnerable to endocrine disruption. Specifically, she wondered if

prenatal exposure to BPA altered estrogen receptor expression in the neonate brain. Rats were gestationally exposed to BPA and on the first day after they were born, in situ hybridization was used to quantify estrogen receptor expression. She found that BPA had significant effects on expression in the mediobasal hypothalamus and amygdala in both sexes. Next, she wondered if these effects would persist into adolescence and adulthood. She focused on the impact of repeated, continuous exposure to BPA and found that it induced age and region specific disruption on the expression of estrogen receptors.

Additionally, Meghan has worked a study in collaboration with the FDA that assessed the effects of BPA exposure on behavior. This study is currently in review and will be used for the future regulation of BPA.

During her relatively short four-year Ph.D. study Meghan has managed to fundamentally improve our understanding of the mechanisms through which endocrine disrupting compounds influence sexually dimorphic neurodevelopment.

We wish Meghan all the best with her future research. She will be missed when she leaves NC State for a postdoctoral position with Dr. Ilona Jaspers at The University of North Carolina. Congratulations on your successful dissertation defense Dr. Rebuli!

Seminars

On March 12, 3:30 pm, Dr. Baldomero Olivera from the Department of Biology and Interdepartmental Program in Neuroscience at the University of Utah will present a seminar titled “Fish-Hunting Cone Snails: What They Teach Us About Drug Design and the Cellular Complexity of Nervous Systems.” The seminar will be in 101 David Clark Laboratories.

At 7:00 pm, Dr. Olivera will present a Science Café public lecture in the Daily Planet Theater of the Nature Research Center at the North Carolina Museum of Natural Sciences, 11 West Jones Street, Raleigh, NC 27601, titled “From Deadly Venomous Cone Snails to Drugs for Pain.”

On **March 23**, 1:30 pm, Dr. Stavros Lomvardas from the Department of Biochemistry and Molecular Biophysics at the Mortimer B. Zuckerman Mind, Brain and Behavior Institute at Columbia University, New York, NY, will present a seminar titled “Molecular Mechanisms of Olfactory Receptor Gene Choice.” The seminar will be in 3503 Thomas Hall.

Grants

Reade Roberts received a three-year \$780,000 grant from the National Science Foundation to study evolutionary genetics of polygenic sex determination in the cichlid species *Astatotilapia burtoni*.

Publications

Dorris, D. M., Cao, J., Willett, J. A., Hauser, C. A. and Meitzen, J. (2015) Intrinsic excitability varies by sex in prepubertal striatal medium spiny neurons. *J. Neurophysiol.* **113**: 720-729.

Wellborn, G. A. and Langerhans, R. B. (2015) Ecological opportunity and the adaptive diversification of lineages. *Ecol. Evol.* **5**:176-195.

Dunn, R. R. (2015) The man who touched his own heart. Little, Brown and Company, publishers.

Mackay, T. F. C. (2015) Epistasis for quantitative traits in *Drosophila*. *Methods Mol. Biol.* **1253**: 47-70.

Booth, W., Balvín, O., Vargo, E. L., Vilímová, J. and Schal, C. (2015) Host association drives genetic divergence in the bed bug, *Cimex lectularius*. *Mol. Ecol.* **24**: 980-992.

Youngsteadt, E., Henderson, R. C., Savage, A. M., Ernst, A. F., Dunn, R. R. and Frank, S. D. (2015) Habitat and species identity, not diversity, predict the extent of refuse consumption by urban arthropods. *Glob. Chang. Biol.* **21**:1103-1115.

Youngsteadt, E., Dale, A. G., Terando, A. J., Dunn, R. R. and Frank, S. D. (2015) Do cities simulate climate change? A comparison of herbivore response to urban and global warming. *Glob. Chang. Biol.* **21**: 97-105.

Veiga-Lopez, A., Pennathur, S., Kannan, K., Patisaul, H. B., Dolinoy, D. C., Zeng, L. and Padmanabhan, V. (2015) Impact of gestational bisphenol A on oxidative stress and free fatty acids: human association and interspecies animal testing studies. *Endocrinol.* **156**: 911-922.

Milbrath, M. O., van Tran, T., Huang, W. F., Solter, L. F., Tarpy, D. R., Lawrence, F. and Huang, Z. Y. (2015) Comparative virulence and competition between *Nosema apis* and *Nosema ceranae* in honey bees (*Apis mellifera*). *J. Invertebr. Pathol.* **125**: 9-15.

Of note...

Robert Anholt served on an NIH study section for predoctoral and postdoctoral National Research Service Award fellowships.

Eric Harris teaches a class on “The Brain for not-so-Dummies” at both the North Carolina State University and Duke Osher Lifelong Learning Institutes this Spring.

John Meitzen presented a seminar on sex differences in striatal neurons at the Laboratory of Neurobiology of the National Institute for Environmental Health Sciences.

Heather Patisaul gave a talk titled “Rewired: endocrine disruption of sexually dimorphic neuroendocrine signaling pathways” at the 8th International Meeting of Steroids and the Nervous System in Torino, Italy. She also serves on the National Research Council Committee on Incorporating 21st Century Science in Risk-Based Evaluation.

John Shorter gave a talk at the Gordon Research Conference on Quantitative Genetics and Genomics in Lucca, Italy.

Visit our website: <http://keck.sciences.ncsu.edu/>

To contribute to The Signal, to be placed on our mailing list or for information about the W. M. Keck Center for Behavioral Biology, contact Dr. Robert Anholt, Department of Biological Sciences, Box 7614, North Carolina State University, Raleigh, NC 27695-7614, tel. (919) 515-1173, anholt@ncsu.edu.

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