

The Signal

Monthly newsletter of the W. M. Keck Center for Behavioral Biology
at North Carolina State University
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A New College - A New Beginning

A Great Year Ahead for the Keck Center

With the creation of the College of Sciences on August 1, North Carolina State University underwent a major reorganization of the Life Sciences, bringing the biological sciences under the same organizational umbrella as the physical and mathematical sciences. The reorganization has been positive for the Keck Center, which has always been and will remain an intercollegiate organization. The reorganization has, however, consolidated the Center as an administrative unit with our own Center account and the formal designation of Suzanne Quick as administrative assistant, a service she has performed *ad hoc* for the last 15 years with great competence. Suzanne will be in charge of all organizational and administrative aspects of the Center, including liaisons with visitors and travel arrangements.

Because of generous support from the new College of Sciences for the 2013-2014 academic year, we can look forward to a stellar series of monthly distinguished lectures by prominent scientists covering the broad area of behavioral biology ranging from ecology and genetics to neuroscience and anthropology. We anticipate having two social evening discussions each semester and our annual student-postdoc symposium has been scheduled for February 21, 2014. In addition we will organize jointly with several other training programs a professional development workshop at the end of the spring semester.

The Keck Center will continue to promote outreach activities. During the Fall semester we will sponsor two public lectures at the North Carolina Museum for Natural Sciences, one by renowned anthropologist Charles Stanish and the other by Lee Dugatkin, well known for his work and books on social behavior. Larry Swanson will present both a research seminar and a public lecture during Brain Awareness week next March.

We are particularly grateful to our corporate sponsors, who have provided generous support for the coming academic year.

Finally, you may note that *The Signal* is now in its fifteenth year of continuous monthly publications. This milestone is possible only because of the enthusiastic participation by our students, postdocs and faculty. I encourage you to continue to contribute to *The Signal*. Remember, anyone can publish in *Science* or *Nature*, but *ONLY YOU* can publish in *The Signal*.

Robert Anholt, Center Director

The Keck Center gratefully acknowledges support by its corporate sponsors.



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 Biology, Box 7617, North Carolina State University, Raleigh, NC 27695-7617, tel. (919) 515-1173, anholt@ncsu.edu.

Tax deductible gifts to the Keck Center can be donated via our secure website.

<http://projects.cals.ncsu.edu/behavioralbiology/>

Managing Mice and Foxes in California

by Megan Serr and Caroline Leitschuh



Santa Cruz Island Fox. Picture courtesy of Lisa McGraw.

While most new students had not even set foot on campus, the 2013 Genetic Pest Management program, funded by the NSF IGERT program, was already underway. Focused on the possible uses of genetics to manage invasive populations of *Mus musculus* on islands, the interdisciplinary cohort includes students from the Zoology program, Caroline Leitschuh and Megan Serr, the Fisheries and Wildlife program, Andrew Ludvik and Rene Valdez, the Biomathematics program, Gregory Backus, and the CRDM program, Elizabeth Pitts. Caroline and Megan are both new graduate students in animal behavior hoping to explore the behavior of invasive *Mus musculus* as well as the behavioral and genetic aspects of gene engineering. This summer, after two days of class in Raleigh, the cohort flew out to California for an intense two-week course on island genetic pest management taught by faculty Erik Aschehoug, Andrew Binder, Matthew Booker, Michael Cobb, John Godwin, Fred Gould, Kevin Gross, and Lisa McGraw. The trip started with a visit to Avalon, Catalina Island, Channel Islands, CA, which included surveying residents and tourists about opinions regarding island conservation and invasive species. Additionally, Julie King from the Catalina Conservancy came and spoke to the group about the ecology of the island and her role in protecting the Catalina Island fox, a subspecies of the Channel Island fox, *Urocyon littoralis*. During the next stop of the trip

at a research station on Santa Cruz Island, we were fortunate to observe several of the foxes. National Park Service member Kate Faulkner, Karl Campbell from the Island Conservation organization, and Peter Alagona, a professor of history at UC Santa Barbara, also joined the group and contributed their experiences and expertise with endangered species conservation and invasive species removal. In addition, our own Erik Aschehoug was able to give insight about his own personal experience dealing with the pig eradication on Santa Cruz Island. The final leg of the trip was a visit to San Francisco and a boat tour of the Farallon Islands, which will be the islands of focus for the cohort. The students also got a chance to speak with Gerry McChesney and Ann Morkill from the USFWS as well as Russ Bradley from Point Blue Conservation Science on their current preparation for mouse eradication on the Farallon Islands. After such an amazing introduction to island conservation, we are back on campus and excited about their future studies and research.



The 17th Annual Society for Behavioral Neuroendocrinology meeting

by Paul Gibson



The NCSU Keck Center for Behavioral Biology delegation in Atlanta

The 17th Annual Society for Behavioral Neuroendocrinology (SBN) meeting was held in Atlanta, Georgia, from June 23rd-27th. Considered the premier meeting for behavioral neuroendocrinology, the conference showcased six symposia including three keynote addresses and three poster sessions. The keynote speakers were Catherine Woolley from Northwestern University, Art Arnold from the University of California at Los Angeles, and Pat Levitt from the University of Southern California. The NCSU Keck Center for Behavioral Biology was well represented with members of the Patisaul lab, McGraw lab, Godwin lab, and Meitzen lab attending and presenting data. Dr. John Meitzen spoke in the Contributed Talks symposium about his research titled “Palmitoylation is essential for estrogen receptors to signal from the neuronal membrane.” Dr. John Godwin spoke in the Neuroendocrine Mechanisms of Vertebrate Social Diversity on “Sex change and sex lability in fishes.” NCSU graduate and undergraduate students participated in the poster sessions held after the symposia to share their research projects and data. From Dr. Patisaul’s lab, five students presented posters, all focused on how endocrine disrupting compounds impact the brain and behavior. Meghan Radford featured a poster titled “Chronic low dose exposure to Bisphenol A significantly alters estrogen receptor expression in the juvenile and adult female rat hypothalamus.” Graduate student Alana Sullivan presented a poster titled “Anxiogenic effects of developmental exposure to an environmentally relevant dose of BPA are mitigated by concomitant administration of a soy rich diet,” and postdoctoral

fellow Jinyan Cao shared her research on “Effect of neonatal Bisphenol A exposure on estrogen receptor beta mRNA levels in the male and female postnatal rat brain.” The undergraduates included Park Scholar Alyssa D’Addezio who presented a poster titled “Hyperactivity and elevated anxiety in female prairie voles developmentally exposed to Bisphenol A is accompanied by changes in oxytocin and vasopressin neuron numbers,” and Park Scholar Austin Bath presented a poster titled “Neonatal genistein exposure alters RFamide expression in the hypothalamus and ovaries.” Finally, from Dr. Godwin’s lab, Ryan Wong shared a poster titled “Sex biased gene expression in the brains of zebra fish (*Danio rerio*): A neurogenomic perspective.” The conference was held at the Loews Atlanta Hotel in the center of the exciting neighborhood of Midtown. Following symposia during the day, students and faculty explored the city and surrounding areas of Midtown including Piedmont Park, the Georgia Aquarium, and local cuisine. I was very excited to have the opportunity to partake in the educational experience of the SBN conference as well as see the culture of Atlanta. I was impressed with the diversity of the talks throughout the symposia and the unique networking opportunity of a large conference such as SBN. Many of the students travelled together to Atlanta and enjoyed the opportunity to get to know each other and share their research interests. The 18th Annual SBN Conference will be held in association with the 8th International Congress of Neuroendocrinology in Sydney, Australia, from August 17th-20th.

Outreach

Reaching Out: High School Students Explore Face Mites with our Team

by Lea Shell and the Your Wild Life team

One of our growing projects in the Dunn lab is the Meet Your Mites project (mymites.yourwildlife.org). It is no surprise that it is so popular – it is a project about little-studied Demodex mites that live in the pores on our faces! Just mention that there is something living on our faces, and the reactions are strong. While they are entirely too small to be felt or seen with the naked eye, mites are likely going about their business on your face right now.



Meet Your Mites! A gallery of face mites from participants is available at mymites.yourwildlife.org

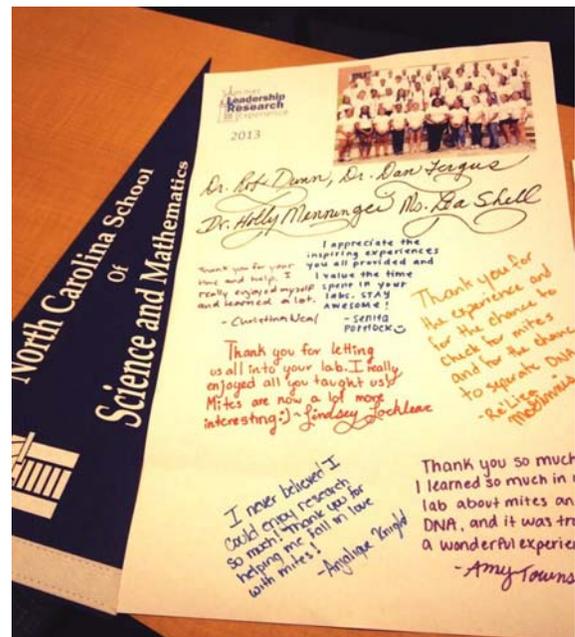
To study them, we gently use a spatula to express and collect sebum from the pores near your nose. We have recently developed new methods that allow us to detect the mites by their DNA - even if we are unable to recover a whole mite in the sample. In July, Dan Fergus, Rob Dunn, Holly Menninger and I shared these new methods with an excited group of high school students. It was extremely rewarding to see the students embrace new laboratory methods and participate in ongoing scientific research in our lab.

The students did not just show up on our doorstep. They are rising juniors and seniors attending the North Carolina School of Science and Mathematics (NCSSM) who participated in NC State's CAALS 3D Program (Creating Awareness of Agriculture and Life Sciences Disciplines, Degree Programs and Discoveries). The goals of the program include increasing minority participation in scientific research and building student awareness and interest in careers in food, agricultural, environmental and life sciences. The students spent a week on the NCSU campus, working with faculty and students and participating in authentic research. Given our lab's focus on public

science, we also provided the students opportunities to do science communication by interacting with incoming College of Sciences freshmen at their orientation.



North Carolina School of Science and Mathematics students learn DNA extraction methods for face mites.



A wonderful Thank You note from our students

Rob Dunn was inspired by the enthusiasm of the students and wrote them a letter of both gratitude and reflection. The full letter can be found at yourwildlife.org in a blog post titled "Dear Students" which ran on July 28, 2013, here is an excerpt:

"Science is equal parts revelation and creation. We reveal truths but also create the tools to see those truths. Now, I will tell you what no one told me when I was 16, but I wish they had. It is a kind of secret. Most of what can be discovered has not yet been discovered."

For more information about our projects: check out our blog at YourWildLife.org and follow us on Twitter @YourWild_Life

Grants

Robert Anholt and **Trudy Mackay** received a four-year \$1,779,351 from the National Institute for General Medical Sciences for studies on molecular genetics of olfaction in *Drosophila*.

Robert Anholt and **Trudy Mackay** received a two-year \$416,625 grant from the National Institute for Environmental Health Sciences for studies on neurogenetics of lead toxicity in *Drosophila*.

Trudy Mackay and **Robert Anholt** received a five-year \$1,893,750 grant from the National Institute on Ageing for studies on systems genetics of life span in *Drosophila*.

Sarah Cash received a one-year \$38,030 predoctoral fellowship from the USDA National Institute of Food and Agriculture to investigate the selfish genetic element *Medea* as a mechanism for suppressing arthropod-vectorated agricultural diseases.

Seminars

On **September 12**, 3:30 pm, Dr. John A. Pickett from Rothamsted Research, Harpenden, United Kingdom, will present a seminar titled "Interactions Between Organisms Mediated by Chemical Signals: From New Genetically Modified Crops to Novel Mosquito Repellents."

The seminar will be in 101 David Clark Laboratories.

On **October 3**, 3:30 pm, Dr. Charles S. Stanish from the Department of Anthropology and the Cotsen Institute of Archaeology at the University of California, Los Angeles, will present a seminar titled "The Emergence of Complex Human Society from a Game Theory Perspective."

The seminar will be in 101 David Clark Laboratories.

On **October 4**, 7:00 pm, Dr. Stanish will deliver a public lecture at the Nature Research Center, North Carolina Museum of Natural Sciences titled "Unlocking the Mysteries of the Ancient Nasca Peoples of Peru."

On **October 8**, 11:00 am, Dr. Raghavendra Gadagkar from the Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India, will present a seminar titled "The Organization of a Tropical Insect Society."

The seminar will be in 3503 Thomas Hall.

Publications

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

Moore, E. C. and Roberts, R. B. (2013) Polygenic sex determination. *Curr. Biol.* **23**: R510-R512.

Heinen, J. L., Coco, M. W., Marcuard, M. S., White, D. N., Peterson, M. N., Martin, R. A. and Langerhans, R. B. (2013) Environmental drivers of demographics, habitat use, and behavior during a post-Pleistocene radiation of Bahamas mosquitofish (*Gambusia hubbsi*). *Evol. Ecol.* **27**: 971-991.

Cao, J., Rebuli, M. E., Rogers, J., Todd, K. L., Leyrer, S. M., Ferguson, S. A. and Patisaul, H. B. (2013) Prenatal bisphenol A exposure alters sex specific estrogen receptor expression in the neonatal rat hypothalamus and amygdala. *Toxicol. Sci.* **133**:157-173.

McCaffrey, K. A., Jones, B., Mabrey, N., Weiss, B., Swan, S. H. and Patisaul, H. B. (2013) Sex specific impact of perinatal bisphenol A (BPA) exposure over a range of orally administered doses on rat hypothalamic sexual differentiation. *Neurotoxicol.* **36**:55-62.

Patisaul, H. B. (2013) Effects of environmental toxicants and phytoestrogens on the kisspeptin system. In: *Kisspeptin Signaling in Reproductive Biology. Adv. Exp. Med. Biol.* **784**: 455-479.

Spanos, M., Gras-Najjar, J., Letchworth, J. M., Sanford, A. L., Toups, J. V. and Sombers, L. A. (2013) Quantitation of hydrogen peroxide fluctuations and their modulation of dopamine dynamics in the rat dorsal striatum using fast-scan cyclic voltammetry. *ACS Chem. Neurosci.* **4**: 782-789.

Roberts, J. G., Lugo-Morales, L. Z., Loziuk, P. L. and Sombers, L. A. (2013) Real-time chemical measurements of dopamine release in the brain. *Methods Mol. Biol.* **964**: 275-294.

Hunt, J. H. (2013) A failure or a decent start? In: *Jahrbuch 2011/2012, Wissenschaftskolleg zu Berlin*. H. Heenemann GmbH & Co. KG, Berlin, pp. 126-129.

Hunt, J. H. (2013) Not only students and postdocs. In *But to Reason Why: Celebrating a Life in Science*. R. Sen and A. Bang eds., G P Solutions, Bangalore. pp. 21-23.

Richard, F. -J and Hunt, J. H. (2013) Intracolony chemical communication in social insects. *Insectes Sociaux* **60**: 275-291.

O'Donnell, S. and Hunt, J. H. (2013) Group hunting by workers of two Neotropical swarm-founding paper wasps, *Parachartergus apicalis* and *Agelaia sp.* *Insectes Sociaux* **60**: 369-372.

Seddon, N.*, Botero, C. A. *, Tobias, J. A., Dunn, P. O., MacGregor, H. E. A., Rubenstein, D. R., Uy, J. A. C., Weir, J. T., Whittingham, L. A. and Safran, R. J. (2013) Sexual selection accelerates signal evolution

during speciation in birds. *Proc. Roy. Soc. B.* **280**: 20131085. *Equal contribution co-first authors.

Gavin, M. C., Botero, C. A., C Bowern, C., Colwell, R. K., Dunn, M., Dunn, R. R., Gray, R. D., Kirby, K. R., McCarter, J., Powell, A., Rangel, T., Stepp, J., Trautwein, M., Verdolin, J. L. and Yanega, G. (2013) Towards a mechanistic understanding of linguistic diversity. *Bioscience* **63**: 524-535.

Botero, C. A. and de Kort, S. R. (2013) Learned signals and consistency of delivery: a case against receiver manipulation in animal communication. In: *Animal Communication Theory: Information and Influence*, U. Stegmann ed., Cambridge University Press, Cambridge, UK. pp. 281-286.

Miravete, V., Roura-Pascual, N., Dunn, R. R., and Gómez, C. (2013) How many and which ant species are being accidentally moved around the world? *Biol. Lett.* **9**: 20130540.

Fitzpatrick, M. C., Sanders, N. J., Normand, S., Svenning, J. C., Ferrier, S., Gove, A. D. and Dunn, R. R. (2013) Environmental and historical imprints on beta diversity: insights from variation in rates of species turnover along gradients. *Proc. Biol. Sci.* **280**: 20131201.

Huang, Y., Wan, P., Zhang, H., Huang, M., Li, Z. and Gould, F. (2013) Diminishing returns from increased percent bt cotton: the case of pink bollworm. *PLoS One* **8**: e68573.

Walsh, R. K., Aguilar, C. L., Facchinelli, L., Valerio, L., Ramsey, J. M., Scott, T. W., Lloyd, A. L. and Gould, F. (2013) Regulation of *Aedes aegypti* population dynamics in field systems: Quantifying direct and delayed density dependence. *Am. J. Trop. Med. Hyg.* **89**: 68-77.

Kobayashi, K., Hasegawa, E., Yamamoto, Y., Kawatsu, K., Vargo, E. L., Yoshimura, J. and Matsuura K. (2013) Sex ratio biases in termites provide evidence for kin selection. *Nat. Commun.* **4**: 2048.

Lowman, M., S. Devy, S. and Ganesh, T. (2013) Treetops at risk: Challenges of global canopy ecology and conservation. Springer.

Of note...

Robert Anholt gave a presentation at the European Society for Evolutionary Biology Conference in Lisbon (Portugal).

Carlos Botero was voted an Elective Member to the American Ornithologist Union for his “significant contributions to ornithology.” He also presented talks at Evolution 2013 in Snowbird (UT), the Entomological Society of America meeting in Minneapolis (MN), and the European Society for Evolutionary Biology Conference in Lisbon (Portugal).

David Dorris will attend the Optical Microscopy and Imaging in the Biomedical Sciences course at the Molecular Biology Laboratory, Cambridge, UK.

Jim Hunt co-authored a poster with A. Behrens and A. Toth, presented at the annual Arthropod Genomics Symposium in South Bend, IN, titled “Transcriptomics of caste development and differential nourishment in primitively social *Polistes* wasps.” He also presented a paper at the annual meeting of the Animal Behavior Society in Boulder, CO, titled “How social wasps evolved.”

Meg Lowman received a Fulbright Senior Specialist Award to Ethiopia in early 2014, where she will mentor women in science and also give workshops on forest conservation. She has worked with National Geographic on saving the last 5% of Ethiopian forests, with a unique partnership linking science to religion.

Trudy Mackay delivered a plenary lecture at the European Society for Evolutionary Biology Conference in Lisbon (Portugal).

Lisa McGraw gave in an invited talk in the “Evolution of Behavior: Comparative Genomics and Transcriptomics” symposium at the Annual Meeting of the Society for Molecular Biology and Evolution in Chicago, IL, entitled “Uncovering the neurogenomic architecture of pair bonding in voles.”

John Meitzen gave a talk at the 2013 Gordon Research Conference on Catecholamines in West Dover, VT.

Heather Patisaul is serving on the National Academy of Sciences committee to evaluate the Environmental Protection Agency document, State of the Science Evaluation: Non-monotonic Dose Responses as They Apply to Estrogen, Androgen, and Thyroid Pathways and EPA Testing and Assessment Procedures. She also gave a talk entitled “Impact of endocrine disruptors on puberty” at the Endocrine Society's 95th Annual Meeting & Expo in San Francisco, CA, and a talk entitled “Endocrine disruption of neuroendocrine pathways” for the National Institute of Environmental Health Sciences Receptor Mechanisms Discussion Group.

Leslie Sombers presented a paper at the 2013 Gordon Research Conference on Catecholamines in West Dover, VT, entitled “Quantitation of hydrogen peroxide fluctuations and their modulation of dopamine dynamics in the rat dorsal striatum using fast-scan cyclic voltammetry.”

John Vandenberg served as a panelist in a Workshop sponsored by the Pew Charitable Trusts in Washington DC on “Potential Conflict of Interest in GRAS (Generally Regarded As Safe) Additive Decisions.” The Panel focused on regulation by the FDA of additive substances, such as bisphenol A (BPA), which is used as a resin to line food cans and as a component of the plastic used to make hard plastic food and water containers in the U.S and has negative developmental consequences on neural, behavioral, and long-term reproductive performance in laboratory animals. The FDA has made recent steps to reduce the amount of exposure to BPA, especially to pregnant women and infants.