

The Signal

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Keck Center's Rob Dunn Pioneers Novel Initiatives for Outreach, Citizen Science and Global Education



Education Pioneer Rob Dunn

Rob Dunn, Associate Professor in the Department of Biological Sciences, has dedicated his career to educate the public about the excitement of scientific discovery. Acclaimed author of several popular science books and frequent contributor to journals like National Geographic, Dunn has pioneered the idea that anyone, from the age of 5 to 85, can experience the rewards of exploring the living world around us.

Dunn has pioneered an extensive outreach and citizen science program, which has attracted national attention. The National Science Foundation has now awarded a five-year \$7.3 million grant to enable Dunn to pursue his citizen science outreach program on a large scale.

The plan is to recruit 10,000 teachers worldwide to participate in an initiative that will enable them and their students to do original scientific research and make their own discoveries. Dunn's group will work together with the Kenan Fellows Program, the Friday Institute, the Science House and the North Carolina Museum of Natural Sciences to develop one of the largest scientific outreach programs of its kind, which will initially focus on seven school districts in North Carolina.

To learn more about how to get involved or register for participation in the "citizen science" program, visit <http://education.yourwildlife.org/>

The Magic of Semiochemicals

by Yvonne Matos

This year's first installment of the W. M. Keck Center for Behavioral Biology distinguished seminar series featured Dr. John A. Pickett from Rothamsted University in the United Kingdom, who presented research from a diverse range of applied projects on chemically mediated interactions among organisms. Pickett is globally recognized as a leader in the semiochemicals of insect behavior and plant defense, and investigates how they can be used in insect control. He earned a B. Sc. and Ph. D, in chemistry and organic chemistry from the University of Surrey and completed postdoctoral training at the University of Manchester. Afterwards he took a position with the Brewing Research Foundation and then moved to Rothamsted Research in 1976. In 1984, Pickett was appointed Head of the Insecticides and Fungicides Department, and in 2007 Scientific Director of the Rothamsted Centre for Sustainable Pest and Disease Management. In 2010, he was awarded the first Michael Elliott Distinguished Research Fellowship at Rothamsted University. Pickett has received numerous awards for his contributions to chemical ecology, including election into the Royal Society in 1996 and the Wolf Foundation Prize in Agriculture in 2008.

Pickett began his seminar with a discussion of genetic manipulations of semiochemicals for crop protection. Many aphids use E- β -farnesene as the major component of their alarm pheromone. Several crop plants naturally produce E- β -farnesene along with inhibitory compounds, and aphids are able to distinguish between alarm pheromone and crops according to the purity of E- β -farnesene. The gene that produces E- β -farnesene was discovered and engineered into plastids that were inserted in *Arabidopsis*, which produced the compound and successfully repelled aphids as well as attracted aphid natural enemies. The gene was also introduced into wheat with similar results.

The next section of the seminar covered a project on push-pull systems in African agricultural systems, with a focus on millet and sorghum crops. Pickett's team seeks to find intercrops and border crops that attract stem borers and their natural enemies. For example, stem borers are attracted to Napier grass planted on the border and are repelled by *Desmodium* legume intercrops. They are also seeking solutions to control *Striga* weeds in these crop systems.

Pickett then touched on a project investigating novel repellents for mosquitoes. It was previously shown that



Dr. John Pickett

mosquitoes are differentially attracted to individual humans, and that 6-methyl-5-hepten-2-one and geranyl acetone are produced by humans that mosquitoes find unattractive. It was found that a 1:1 ratio of these compounds could achieve 100% repellency in arm-in-cage tests.

The next project discussed was a transgenic salmon that repels the economically devastating salmon louse. A gene that produces unattractive odors in turbot, a non-host fish, was engineered into the salmon to produce repellency toward the salmon louse.

Dr. Pickett concluded his seminar by touching on projects that aim to reduce the spread of blue tongue virus in sheep in India and aim to develop a fly repellent for cows using odors produced by naturally repellent cows.

Pickett's seminar demonstrated the enormous potential of the use of semiochemicals for pest control.

Parents, Peers, and Delinquency

by Emily Moore

The first Keck Center social evening discussion of the 2013-2014 season featured an interdisciplinary discussion led by Dr. Stacy De Coster, from NCSU's Department of Sociology and Anthropology. De Coster's research addresses sociological influences on delinquent behaviors, focusing on the impact of inequality, gender, and mental illness on delinquency (as defined by the law). She utilizes nationwide, longitudinal health studies (such as the Add Health adolescent study out of Chapel Hill and self-reporting strategies, and employs a statistical toolbox to control for additional sociological factors. The discussion focused on just a few of the many nuanced, interacting factors influencing delinquent behavior - parents, peers, and biology. De Coster introduced three main paradigms that are used by sociologists to try to understand the basis for delinquent behavior and discussed models of biological influence, each aspect adding an additional layer of complexity to consider in understanding how people become driven to crimes.

Social control paradigm, the most basic of the three theories, begins with the Hobbesian assumption that humans are naturally selfish, and that social pressures are needed to control evil desires. Close social relationships give us something to lose if we give into delinquent impulses, thus we have a "stake in conformity." De Coster noted that there is mixed empirical evidence for this theory; close relationships with parents are correlated with lower levels of delinquent behavior, but close relationships with peers are not correlated with decreased crime (in adolescence, peer relationships may actually be associated with an increased rate of delinquency).

Differential association and social learning theory changes the assumption that human nature is evil, and adds in the influence of the content of our relationships; as parents and peers provide favorable or unfavorable definitions of delinquency, we weigh their opinions of delinquent acts such that our definitions of what is "good" and "bad" reflect those whose social relationships we most value. We are a society of subcultures, claims De Coster, and the heterogeneity of larger society can allow for many sub-cultures that maintain different definitions of delinquency. Social association theory accounts also for the changes to societal definitions of delinquency, which shift over time to criminalize previously acceptable acts (such as segregation) and decriminalize others (such as the end of prohibition). This theory also accounts for the rise, and subsequent drop, of delinquent acts during adolescence; the flexibility of teen social networks allows for peer pressure to become a predominant force during this time in development.

The previous theories do not account for non-positive relationships (such as bullying, social isolation, and parental abuse) leading to delinquency, which is where the strain/stress perspective comes in. Humans experience different stressors, from those considered "daily hassles" to serious life events, which can precipitate delinquent behavior. Studies have indicated that daily hassles (and not traumatic events) are more likely to influence delinquency, possibly because of the differences in social support.

Biology is another important factor in understanding delinquency; however, a history of employing now-defunct, racist "scientific" theories has made some sociologists apprehensive about examining biological contributions to criminal behavior. Genetic variation in behavior is a topic of ongoing research at North Carolina State University, and De Coster addressed recent research of the interactions between genes and social environment. Statistical associations between life stressors, depression, and variants of serotonin transporter gene have identified allelic differences that influence behavioral stress response. Genetic influences on criminality have also been studied by comparing the delinquency of adopted children to that of their adoptive and biological parents. In the vein of Phineas Gage, neuroscience and sociology have also converged to study changes in social behavior following micro-strokes, which can be examined via MRI. In addition to individual biology, the interactions between the non-social environment, delinquency, and environmental toxins are beginning to be more thoroughly examined; for example, prenatal exposure to cigarette smoke has been associated with delinquent behaviors. Sex differences in rates of delinquency are studied by De Coster with regards to socialized gender roles, but are have also been studied in light of hormone differences between the sexes.

A concluding theme of the night pulled together biological and sociological theory; are there biological circumstances in which delinquency would be beneficial? For the individual, De Coster suggested that delinquent acts in adolescence can help to foster autonomy (people who never do any delinquent behaviors can be very socially awkward), and that adolescent delinquency may be a normal part of developing independence. On a societal scale, an act considered "delinquent" in one sub-culture may be advantageous in another, similar to the variation we see in non-human social systems; for example, fighting can display strength in inner city Chicago, making the cost of non-violence (further retaliation) much higher than the cost due to injury from initial fight, or judicial consequences. Ultimately, delinquency might be evolutionarily selected for if it allows our societies to remain flexible, providing the variation in behavior needed for society to adapt to ever changing physical and social surroundings.

Genomics of Complex Diseases

by Jessica Nye

The 7th annual Genomics of Common Diseases conference was held on the enchanting campus of Keble College in Oxford, UK. The conference is dually hosted by Nature Genetics and the Wellcome Trust Foundation. Genomics of Common Diseases was an intimate affair with just about 200 attendees. Invited speakers represented countries from all over the world and many disciplines and featured over 100 posters.

The conference began with a keynote speech from Aravinda Chakravarti from the University of Oxford. Chakravarti spoke about the work he has amassed throughout his career which has focused on Mendelian inherited hemoglobin defects. Much of his work has focused on the population in Northern India where 80% of those indigenous to that area are carriers of this disease. His work has shown that although a Mendelian disease is thought to be simple in nature when compared to other diseases, there is a complex epistatic interaction of genetic factors that may result in a more or less severe phenotype. Dr. Chakravarti's keynote talk certainly hit the pin on the head that the genomics of human diseases is complex.

The conference proceeded with talks about the most up-to-date research in a clinical setting. There were discussions on personalized medicine and the interaction of genomics and antibiotics, and on how collecting genome-wide data in populations may help predict the appropriate treatment necessary to remedy an illness. We also heard about recent advances into the two diseases that are the leading cause of death in the world, cardiovascular disease and cancer. The current methods used to discover genes of interest were discussed, and new methods other than traditional genome-wide association tests were introduced.

Animal models for human diseases were also represented. Arthur Korte from the Gregor Mendel Institute discussed how basic research into the *Arabidopsis* genome can have implications on studies into human diseases. Allan Bradley from Wellcome Trust Sanger Institute discussed the progress of using humanized mouse models to experiment on human orthologs in the mouse model. North Carolina State University's own Kelsey Poorman from the veterinary school discussed how she uses dogs as a model for oral melanoma in humans.

The two poster sessions featured projects on a diverse array of human diseases, animal models for human diseases, and theoretical modeling. This conference certainly offered exceptionally interesting presentations for anyone interested in human diseases, models for human diseases, or even the complex networks that form phenotypic traits.

Outreach

BugFest and Education Resources

by Lea Shell and the Your Wild Life team

This past month our group received some incredible news about our future potential to do outreach. Over the next five years we will be partnering with 10,000 teachers within North Carolina and across the world to bring authentic research experiences and citizen science into K-12 classrooms, with a special focus on middle school curriculum! Our bigger goals involve improving student outcomes as well as increasing teacher enthusiasm – and having students participate in real scientific research in the classroom. It is beyond exciting to know that the work we do to reach out into classrooms will be replicated and used all over the world! We even received pictures a couple weeks back of students doing our Belly Button Biodiversity module in Australia. The e-mails from motivated educators keep pouring in and we cannot wait to hit the ground running. Find out more about our education efforts at education.yourwildlife.org.



Mack Pridgen of Tar Heel Ants (and an unofficial member of our team) holds one of his ant colony nest boxes. Read our interview at yourwildlife.org.

Photo credit: Lea Shell

Four members of our team, Dr. DeAnna Beasley, Lauren Nichols, Mack Pridgen and I went to Durham to speak to an excited group of second graders about ants. While we were there, students asked incredible questions – like, “What is a colony?” and “Why are ants so strong?” – questions that continue to stump even the brightest of Ph. D. candidates. Our team used their expertise to answer some hard-hitting questions, and there is a short video compiling the students' questions (and our answers) along with some footage from one of Mack's ant colonies – check out “Ant Questions Answered” at yourwildlife.org.



Dr. Clint Penick begs the question, “What is that smell?” and has BugFest visitors “squash and sniff” Odorous House Ants in order to find out! Results can be found at YourWildLife.org.

Photo credit: Holly Menninger

Grants

Rob Dunn received a five-year \$7.3 million grant from the National Science Foundation to initiate and spearhead citizen science projects.

David Tarpy received a one-year \$29,480 grant from Project Apis m (Pam) to study development of a high-throughput method for quantifying sperm viability in honey bee queens.

David Tarpy received a one-year \$15,000 grant from the North Carolina Department of Agriculture and Consumer Services, Plant Industry Division to study how urbanization and management practices affect honey bee immunology and disease ecology.

David Tarpy, together with M. Huang and M. Corona, received a one-year \$10,050 grant from the National Honey Board for improving honey bee queen quality via nutritional and hormonal treatments.

David Tarpy, together with H. Matilla and I. Newton, received a one-year \$10,050 grant from the National Honey Board for linking the microbiotas of honey bee queens to their reproductive performance and colony productivity.

Our team also ventured to the Biodiversity Lab at the North Carolina Museum of Natural Sciences for the annual BugFest. What better way to reach out than to have 35,000+ bug enthusiasts come to you? We had groups sniffing squashed ants, signing up to be one of our 10,000 teachers, learning about arthropods found in homes, learning more about ants and even sharing camel cricket sightings. All in all, we consider that a success!

More and more we learn that our outreach takes on many different forms; whether it is a new grant facilitating more connections with educators, inspiring classroom visits, or giant planned events at the museum. Our team continues to find incredible rewards in sharing what we have learned in the lab with others, and we cannot wait to get more students asking questions about the world around them.

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

Seminars

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.

On **November 7**, 3:30 pm, Dr. Lee Dugatkin from the Department of Biology at the University of Louisville, will present a seminar titled “The interaction of genetic and cultural transmission in shaping mate choice in animals and humans.” The seminar will be in 101 David Clark Laboratories.

On **November 7**, 7:00 pm, Dr. Dugatkin will deliver a public lecture at the North Carolina Museum of Natural Sciences titled “Mr. Jefferson and the Giant Moose: When Natural History and History Collide”

Publications

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

Boncrisiani, H. F., Evans, J. D., Chen, Y., Pettis, J., Murphy, C., Lopez, D. L., Simone-Finstrom, M., Strand, M., Tarpy, D. R. and Rueppell, O. (2013) *In vitro* infection of pupae with Israeli Acute Paralysis Virus suggests variation for susceptibility and disturbance of transcriptional homeostasis in honey bees (*Apis mellifera*). *PLoS ONE* **8**: e73429.

Tarpy, D. R., vanEngelsdorp, D. and Pettis, J. S. (2013) Genetic diversity affects colony survivorship in commercial honey bee colonies. *Naturwissenschaften* **100**: 723-728.

Niño, E. L., Tarpy, D. R. and Grozinger, C. M. (2013) Differential effects of insemination volume and substance on post-mating changes in honey bee queens (*Apis mellifera* L.). *Insect Mol. Biol.* **22**: 233–244.

Lugo-Morales, L. Z., Loziuk, P. L., Corder, A. K., Troups, J. V., Roberts, J. G., McCaffrey, K. A. and Sombers, L. A. (2013) Enzyme-modified carbon-fiber microelectrode for the quantification of dynamic fluctuations of nonelectroactive analytes using fast-scan cyclic voltammetry. *Anal. Chem.* **85**: 8780-8786.

Heinen-Kay, J. L. and Langerhans, R. B. (2013) Predation-associated divergence of male genital morphology in a live bearing fish. *J. Evol. Biol.* **26**: 2135–2146.

Robert, M. A., Okamoto, K., Lloyd, A. L. and Gould, F. (2013) A reduce and replace strategy for suppressing vector-borne diseases: insights from a deterministic model. *PLoS One* **8**: e73233.

Saenz, V. L., Maggi, R. G., Breitschwerdt, E. B., Kim, J., Vargo, E. L, and Schal, C. (2013) Survey of *Bartonella* spp. in U.S. bed bugs detects *Burkholderia multivorans* but not *Bartonella*. *PLoS One* **8**: e73661.

Of note...

Robert Anholt delivered a plenary lecture on the “Genetics of Alcohol Sensitivity: Lessons from *Drosophila*” at the annual meeting of the German Genetics Society in Braunschweig, Germany.

John Godwin gave the departmental seminar in the Department of Biology at the College of William and Mary.

David Tarpy presented seminars at the USDA Bee Research Laboratory (Beltsville, MD) and the Department of Entomology at the University of Maryland (College Park, MD). He also conducted a Science Café as part of the Invited Public Lecture series of Sigma Xi and the North Carolina Museum of Natural Sciences. He also presented posters with **Carl Giuffre**, **Ming Hua Huang**, and M. Corona at the

BASF symposium in Research Triangle Park, RTP, on assessing sub-lethal pesticide effects on non-target organisms using digital image processing and on improving honey bee queen quality via nutritional and hormonal treatments. Together with **Juliana Rangel**, **Katalin Boroczky** and **Coby Schal** he presented a poster at the ABS conference in Boulder CO titled “Honey bee (*Apis mellifera*) queen reproductive potential affects queen mandibular gland pheromone composition and worker retinue response.” He also gave poster presentations with van Engelsdorp, Spivak, and Lengerich at the Monsanto Bee Conference in St. Louis (MO), titled “The Bee Informed Partnership: A multi-pronged extension effort aimed at reducing colony losses,” and with **Justin Radloff** and **Michael Simone-Finstrom** at the North Carolina State University Undergraduate Research Symposium in Raleigh (NC) on measuring stress and recombination rates in migratory honey bee colonies. **Juliana Rangel**, **Jennifer Keller**, and **David Tarpy** presented a poster at the Entomological Society of America South West Branch meeting in Las Cruces (NM), on the effects of commonly used miticides on the growth of honey bee (*Apis mellifera*) colonies.

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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.

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