

Newsletter of the National Evolutionary Synthesis Center, an NSF-funded collaborative research center operated by Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University.

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NEXT PROPOSAL DEADLINES:

NESCent has hosted nearly 5000 scientists from more than 50 countries. You could be one of them. We are now welcoming applications for the following:

Jan. 15: journalists-in-residence

April 1: short-term visitors

July 1: graduate fellowships, short-term visitors

July 10: sabbaticals, catalysis meetings, working groups

For more information, turn to page 8 or visit nescent.org/science/proposals.php

JOB OPENINGS

Interested in employment opportunities at NESCent? Our center runs with the help of a dynamic team of programmers, financial experts, event planners, and other specialists. To find out about job openings as they become available, visit nescent.org/about/employment.php.

OUTREACH

Bolstering evolution education in the Caribbean

More than half of 11th and 12th grade high school teachers in Belize feel unprepared to teach evolution, finds a recent survey. And yet, the Caribbean region is a hotspot for biodiversity, not to mention home to several textbook examples of evolution, such as the radiation of Anolis lizards.

Those were just some of the reasons why NESCent headed to the Caribbean this fall in the latest installment of the new “NESCent Ambassador program,” which helps US-based scientists connect with researchers worldwide.

The NESCent team visited several Caribbean nations — Belize, Barbados, Jamaica, and the Republic of Trinidad and Tobago — to offer a series of workshops on evolution education to high school teachers and undergraduate instructors, in collaboration with our partners at the Caribbean Examinations Council (CXC), the group charged with overseeing curriculum throughout the region.

Council member Elvis Nuñez, a science educator and curriculum consultant originally from Belize, led the trip. Together with the NESCent team of Allen



NESCent postdoc Clint Francis answers questions from students at Excelsior High School in Kingston, Jamaica

Rodrigo, Jory Weintraub, Craig McClain and Clinton Francis, the group shared their research, engaged students and instructors with everyday examples of evolution, and exchanged education resources and strategies.

For example, NESCent

Director Allen Rodrigo described his research on rapidly evolving viruses such as HIV. The Caribbean is more heavily affected by HIV and AIDS than other regions of the world, second only to sub-Saharan Africa, according to

see **CARRIBEAN**, p 4

ABOUT NESCENT:

NESCent is a scientific research center dedicated to cross-disciplinary research in evolution. The center's mission is to promote the synthesis of information, concepts and knowledge to address significant, emerging, or novel questions in evolutionary science and its applications. NESCent achieves this by supporting research and education across disciplinary, institutional, geographic, and demographic boundaries.

NESCent is a collaborative partnership between Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University, and is funded by the National Science Foundation (award #EF-0905606). For more information about research and training opportunities at NESCent, visit www.nescent.org.

SENIOR LEADERSHIP:

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STAY INFORMED

Subscribe to the NESCent quarterly newsletter to receive news about the Center, research and training opportunities, and upcoming events. Comments, story ideas and photo contributions are welcome. Please send corrections and suggestions for future newsletters to Robin Smith at rsmith@nescent.org

To unsubscribe fill out our online form at bit.ly/qIuEWu. You can also visit NESCent on Twitter, Facebook, and YouTube.

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To read more about the NESCent Ambassador program, see the cover story.

Letter from the director

I am writing this on the day of the NESCent holiday party, and since we've had a good year, we've got lots to celebrate. We began quite a few new programs this year — our targeted science programs, the NESCent Academy, the Darwin Day Roadshow, and the Evolution Video Competition — and we are looking forward to continuing these in the next few years.



**ALLEN
RODRIGO**

One program that I have personally been involved in is the NESCent Ambassador Program. This program, supported by a NSF EAGER grant, aims to take evolutionary science to places around the world where there are exciting opportunities for collaboration, education and outreach. In this newsletter, you will read about our first Ambassadorships, two of which I have had the privilege to participate in personally. Each of the Ambassadorships have been different, with different audiences, different communities and, obviously, different cultures. But the one thing that stands out in my mind is this: there are scientists, researchers, teachers and students who are intelligent, enthusiastic, and motivated, and who can bring fresh, novel, and innovative perspectives on our understanding of the world, but

are held back by the circumstances of their situation — social and economic pressures, or a lack of resources and infrastructure.

Science does not respect national or geographic boundaries, and no one culture or country has a monopoly on good ideas. For this reason, NESCent welcomes international participants at its meetings. This is also one of the reasons why we think the Ambassador program is so important. But I always leave wishing I could do more, wishing that I could offer a space in my lab to the two, or ten, or thirty, bright, energetic, young scientists or students I meet. Of course, we are necessarily bound by the constraints of resources and regulations on what we can do, and for good reasons. Within these boundaries, though, NESCent will continue to build on what it sees as the three pillars of scientific synthesis: connecting, sharing, and transforming. Whether these involve data and disciplines, or people and communities, NESCent remains committed to these goals.

I wish you a year filled with the excitement of discovery, insight, and learning.

COMING SOON

NESCent hits the road for Darwin Day 2012

What: Darwin Day Roadshow

When: February 2012

Where: Coming to a state near you

Every year on Feb. 12th, the world throws Charles Darwin a birthday party and celebrates the contributions he made to our understanding of evolution. NESCent celebrates by taking Darwin Day on the road and sending our scientists around the country to talk about their work in a program we call the "Darwin Day Roadshow."

The goals of the Darwin Day Roadshow are to promote an awareness of, and appreciation for, evolutionary science, and to personalize it by bringing NESCent scientists into classrooms and town halls all around the country – focusing on smaller, more rural communities

not typically served by universities, museums, or other institutions. Our scientists also talk to students about the rewards and challenges of pursuing careers in science, and a typical day in the life of an evolutionary scientist.

This year, we received over 100 applications from 27 different states, and selected schools in Oregon, Washington, Arkansas, Missouri, Louisiana, West Virginia and North Carolina. The educators at these schools will act as local hosts, helping us organize events in their classrooms and in the surrounding community. In return, they will receive a collection of books, videos, and other resources to enhance the teaching of evolution in their classrooms.

To learn more about the Roadshow, and see pictures and stories from last year, visit roadshow.nescent.org.

COMING SOON

Celebrate Darwin Day 2012 at the NC Museum of Natural Sciences

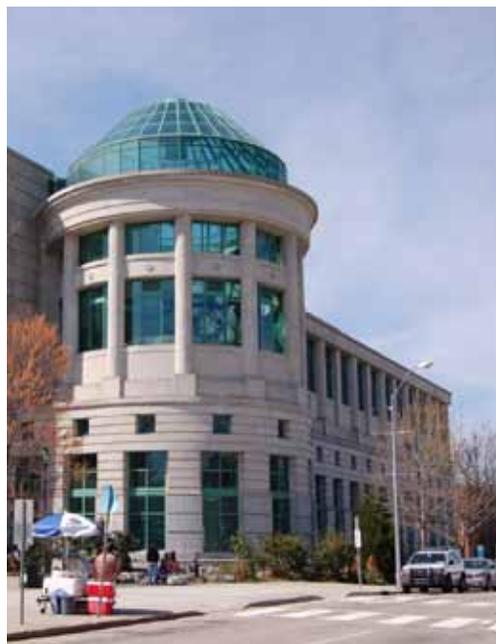
Where: North Carolina Museum of Natural Sciences, Raleigh

When: February 11, 11 AM - 5 PM, FREE

If you're in central North Carolina and you're interested in evolution, the place to be on Saturday, February 11th is the North Carolina Museum of Natural Sciences in downtown Raleigh. Once again, NESCent is partnering with the museum to co-organize a day-long celebration of Charles Darwin and evolution. From 11:00 AM to 5:00 PM, the museum will open its doors (free of charge) and feature hands-on activities, booths, tables and stations designed to engage and inform the public about what evolution is and how it is relevant to all of us, and the many contributions Darwin made to our understanding of the field.

That afternoon, the keynote speaker will be Dr. Roland Kays, whose "Cooking the Tree of Life" program highlights the evolution of domesticated food. In "Some like it hot!" Kays will team up with a local chef to prepare foods and facts related to chili peppers. Learn about the secrets of chili peppers while sampling delicious chili-inspired foods prepared live while you watch.

The museum expects to attract more than 2,000 visitors to this year's event, which



marks its third annual NESCent co-sponsored Darwin Day. So, if you're looking to celebrate Charles Darwin's 203rd birthday on February 11th, 2012, come to the NC Museum of Natural Sciences and check out all the fun! For more information, visit naturalsciences.org/programs-events/darwin-day-0

COMING SOON



Register for NESCent Academy

If you are a grad student, postdoctoral fellow or junior faculty member, watch the NESCent website and Twitter feed as well as your favorite evolutionary biology news sources in early 2012 for information about registering for our next round of short courses through the newly-launched NESCent Academy program. Each course is 1-2 weeks long, taught by experts in their fields, and includes lectures balanced by hands-on activities.

We are excited to announce the following short courses for 2012:

- Evolutionary quantitative genetics
- Next-gen sequencing: data acquisition, comparative genomics, design and analysis for population genetics, systematics and development
- Anatomy ontologies in evolutionary biology and genetics

For more information about instructors, dates, and how to apply, visit academy.nescent.org/wiki/Main_Page or contact Dr. Karen Cranston at karen.cranston@nescent.org.



Students from high schools throughout Jamaica listen to presentations by NESCent Ambassadors

CARRIBEAN, continued

figures from the World Health Organization.

“Evolution research is important for figuring out where an infection comes from, whether drugs are working effectively, and how the disease is likely to progress,” Rodrigo explained.

The Caribbean trip was one of four trips sponsored by the NESCent Ambassador program so far, thanks to a two-year, \$246,515 grant from the National Science Foundation. Each Ambassadorship aims to leverage the expertise of NESCent scientists and educators to address challenges

in evolution education, data management, data analysis and other issues. Over the two years of the program, NESCent expects to match US-based scientists with scientists and communities across the globe. The next Ambassadorship, scheduled for the spring of 2012, will send scientists to the Kenyan Medical Research Institute (KEMRI) in Kilifi, Kenya, to deliver a two-week workshop to local scientists on phyloinformatics. ●

To find out more about NESCent workshops offered around the world, and how you can get involved, visit ambassadors.nescent.org/.

Bigger birds are harder hit by human noise

A growing body of evidence shows that man-made noise is bad for birds, but some species are harder hit than others — particularly bigger birds with low-frequency songs, finds a new study led by NESCent postdoc Clinton Francis.

“Bigger birds sing at frequencies that are more easily masked by the low frequencies typical of human noise pollution,” Francis said.

The findings aren’t just important for birds. The larger species in Francis’s study, for example — such as western scrub jays and pinyon jays — are also important seed dispersers for trees like pines and oaks. This means human noise could be bad news for

tree seedlings, too.

Birds rely on sound to find mates and avoid danger. Human-generated noise such as the roar of traffic or the hum of machinery can make it harder for birds to hear each other’s chirps, whistles and trills.

Since the 1980s, studies have documented decreases in bird density near roads and other noisy areas. Francis and his colleagues have been trying to pinpoint what might be causing these declines, and whether some species fare worse than others.

From 2005 to 2007, Francis and his team counted birds and nests in the Bureau



Though large birds like the Western Tanager sing louder than smaller birds, their songs are more often drowned out by man-made noise.

see **BIG BIRDS**, p 12

COMING SOON

Apply for an undergraduate travel award to attend Evolution 2012

Deadline March 1, 2012

NESCent is again co-sponsoring travel awards for students who wish to attend the annual Evolution meeting. Thanks to a partnership with Scott Edwards (Harvard University) and Rich Kliman (Cedar Crest College), the program will provide travel fellowships for up to 25 undergraduates to attend this year's SSE/SSB/ASN meeting, to be held in Ottawa, Canada, from July 6-10, 2012. This year's conference will be the first ever joint conference with the Canadian Society for Ecology and Evolution (CSEE) and the European Society of Evolutionary Biology (ESEB), so it promises to be even more exciting and stimulating than usual!

We are looking for talented and diverse undergraduates to attend and present their research. They will also participate in

mentoring and professional development events and social activities, which will enable them to start building their network of evolutionary biology colleagues.

All expenses (travel, room, board, meeting registration) are covered. Students need not be members of under-represented groups to apply. Those demonstrating a need for funds will be given preference, and will be selected so that as a group, they will maximize cultural diversity among undergraduates at the meetings. The application deadline is March 1st, 2012.

For more information visit oeb.harvard.edu/faculty/edwards/community/application.html or contact Dr. Jory Weintraub at jory@nescent.org.

NESCent outreach dips into SALSA!

NESCent recently expanded its minority outreach efforts with an education program called "Seeing and Learning Science After-school," or SALSA! The program was the brainchild of NESCent postdoctoral fellow Rafa Rubio de Casas and his undergraduate intern Sarah Cohn, a senior at UNC Chapel Hill. Rafa and Sarah knew they wanted to develop a project related to evolution education that served underrepresented minority students. Sarah had previously volunteered at a local after-school program run by the Chapel Hill/Carrboro Human Rights Center that serves primarily elementary school students from Latino and Burmese immigrant families. It occurred to her that this center represented an ideal venue for a science outreach program, so she, Rafa and NESCent's Jory Weintraub (Asst. Director of Education & Outreach) approached the after-school center and pitched their idea to bring evolution outreach activities directly to the students.

The team developed a series of four workshops featuring hands-on, inquiry-based activities built on an evolutionary theme. They were joined for some of the sessions by several other NESCent postdocs (Juan Santos, Carlos Botero and Paul Harnik), who



helped lead the activities and explain concepts to the kids. The program culminated with a "Parents' Night" event, during which kids and parents visited the center, watched a slide-show featuring the kids engaged in science exploration, heard directly from the kids about what they learned, and listened to a presentation from Rafa on opportunities for their kids to pursue studies and careers in science. The event was capped off with each child receiving a "diploma" acknowledging their participation in SALSA!

During the Spring 2012 semester, the NESCent team plans to implement it at a Hispanic Community Center in Durham, NC, so please stay tuned!

COMING SOON

Travel award for faculty from MSI's

Apply for travel award to attend Evolution 2012

Deadline: March 21, 2012

NESCent and the Society for the Study of Evolution (SSE) are pleased to announce a travel award for faculty from Minority Serving Institutions (MSIs) to attend Evolution 2012, to be held in Ottawa, Canada, from July 6-10, 2012.

If you are a faculty member at an MSI, HBCU or other institution with significant enrollment of under-represented minority students, you are encouraged to apply. Funds to cover conference registration, travel, food and lodging for up to three individuals.

To apply, fill out the online form at <http://tinyurl.com/csvq6zf>. The application deadline is March 31st, 2012. Awards will be announced by April 9th, 2012. For more information, please contact Dr. Jory Weintraub at jory@nescent.org.

Video Competition

Deadline: June 29, 2012

NESCent invites scientists of all stripes – graduate students, postdoctoral fellows and faculty – to enter the second annual Evolution Video Competition. To enter, please submit a video that explains a fun fact, key concept, compelling question, or exciting area of evolution research in three minutes or less. Entries may be related or unrelated to your own research, and should be suitable for use in a classroom (K-12, undergraduate, graduate – your choice). Videos should be both informative and entertaining. (In other words, no taped lectures or narrated Powerpoint presentations!) Animations, music videos, and mini documentaries are all fair game. To enter your video, please visit filmfestival.nescent.org/.

Growing numbers of authors, journals join the data publishing bandwagon

Thanks to your submissions, the Dryad digital repository now contains over 2700 data files from over 100 journals across the biosciences. From the African Journal of Herpetology, to Zootaxa, authors and journals from around the world are choosing to archive their data in Dryad, making the data widely available for reuse by other researchers (& not locked up behind a publisher's paywall), and preserving them for future generations, or unanticipated new uses.

Meet the latest journals to have articles with data in Dryad:

- Animal Behaviour (Elsevier)
- Bioinformatics (Oxford)
- Biological Conservation (Elsevier)
- Ecological Applications and Ecology (Ecological Society of America)
- Castanea (BioONE)
- Gene (Elsevier)
- International Journal for Parasitology (Elsevier)
- Journal of Biogeography (Wiley)
- Journal of Tropical Ecology (Cambridge Univ. Press)
- Journal of Vertebrate Paleontology (BioONE)
- Oikos (Wiley)
- The Plant Cell (American Society of Plant Biologists)
- Plant Signaling and Behavior (Landes Bioscience)
- Symbiosis (Springer)



Recently, several journals have implemented manuscript integration with Dryad, greatly facilitating their authors' data archiving. Among the newly integrated journals are:

- Ecological Monographs
- Paleobiology
- ZooKeys

If you read or publish in any of these journals, you may notice a reference to the availability of the supporting data in Dryad. This could look like a short note and a link:

Data deposited in the Dryad repository:
doi:10.5061/dryad.8875

or take the form of a citation:

Data: Hartfield M, Otto SP (2011) Data from: Recombination and hitchhiking of deleterious alleles. Dryad Digital Repository. doi:10.5061/dryad.8875

Authors who deposit their data in Dryad know that using Dryad is simple and rewarding and that their data files are...

- available to all without restrictions
- preserved for posterity with a stable digital identifier
- independently findable, providing

more visibility for the article and authors

- citable and downloadable (and sharable via social media)

Additionally, authors who deposit in Dryad...

- are able to see how many times their data files have been viewed and downloaded
- save time by directing individual requestors seeking the data to Dryad
- can consider data creation and sharing as a scholarly output (add a Data Publications section to your CV!)

You can realize these benefits too....

- **authors:** publish your data in Dryad (see 2 minute video at <http://bit.ly/s2MoIm>)
- **peer reviewers:** recommend that authors deposit their data in Dryad
- **editors:** include Dryad and data archiving in Instructions to Authors, or go a step further and facilitate your authors' data deposits by setting up automatic notifications to Dryad from the journals' manuscript submission system.

In October, Dryad received its 1000th data package. What have we learned from the first 1000 submissions?
<http://bit.ly/qy8vsvd>

RESEARCH HIGHLIGHTS

Student software developers showcase their work

For the fifth summer in a row, NESCent offered a number of internships aimed at introducing students to open-source software development in evolutionary biology.

This summer, eight interns from the 2011 Google Summer of Code™ program worked remotely on an informatics project of their own choosing, each under the guidance of an

experienced mentor. NESCent's 2011 Summer of Code students included Jan Engelhardt, Alexandru Lucian Ginsca, Sarah Hird, Peter Hoffman, Daniel Packer, Andrei-Alin Popescu, Apurv Verma, and Laurel Yohe. Their projects ranged from manipulating next-generation sequencing data for population genetic analysis, to enabling a frequently-used alignment

viewer to analyze non-coding RNAs, to generating human readable text that could be integrated into Encyclopedia of Life from ontologies containing phenotype data.

Meet the students and learn more about their projects at informatics.nescent.org/wiki/Phyloinformatics_Summer_of_Code_2011/Summaries.

AWARDS

Congratulations to the newest award recipients for 2012

NESCent is pleased to announce the following new awards:

CATALYSIS MEETINGS

Alan Bergland and Dmitri Petrov (Stanford University) and Paul Schmidt (Univ. of Pennsylvania) *Tracking the biotic response to global climate change through genomic analysis*

Michele Dudash (University of Maryland-College Park) and Nat Holland (University of Houston) *Transitions between mutualism & parasitism: integrating theory and evolution*

John Logsdon (University of Iowa) and Lauri Lebo (Freelance) *Education outreach – Reporting across the culture wars: engaging media on evolution*

Clifton Ragsdale (University of Chicago), Laure Bonnaud (University of Paris) and Leonid Moroz (University of Florida) *Paths to cephalopod genomics – strategies, choices, organization*

Peter Ungar and Jerome Rose (University of Arkansas) and John Sorrentino (dentist) *Evolution of human teeth and jaws: implications for dentistry and orthodontics*

WORKING GROUPS

Jason Hoeksema (University of Mississippi) *A working group to solve problems in model selection and phylogeny in mixed multi-factor meta-analysis*

SABBATICAL SCHOLARS

James Chisholm (University of Western Australia) *Emotion and the evolution of culture*

SHORT-TERM VISITORS

Alan Bittles (Murdoch University) *The mating structure of early human populations, and its genetic consequences*

Corey Hart (Drexel University) *Seeing is believing: creating 3D environments to facilitate evolutionary education*

Robert Lanfear (Australian National University) *Synthesizing methods and data to understand the mutational processes that shape genomes*

Iliana Medina (Universidad de los Andes) *Does environmental tolerance favor signal variability in calls of songbirds*

Rubén Torices (University of Coimbra) *The evolution of dispersal syndromes: a case study with the tribe Cichorieae (Asteraceae)*

GRADUATE FELLOWS

Daniel Griffith (Wake Forest University) *Origins of the C4 grassland system: phylogenetic biome assembly*

Anna Hiatt (Oklahoma State University) *Evaluation of the validity and reliability of the Evo-Devo Concept Inventory*

Kristin Lamm (North Carolina University) *A quantitative way to identify ancestors in the fossil record*

Elizabeth Scordato (University of Chicago) *The role of divergence in multiple sexually selected traits in speciation by sexual selection*

EVOLUTION BLOG CONTEST

Winners: Catherine Pratt (Brown University) and Sarah Seiter (UNC-Chapel Hill)

First runners up: Rachael Bloom (UNC-Chapel Hill), Elizabeth Preston (MUSE Magazine, Chicago), Andrew Thaler (Duke University)

For more information about these scholars and their research projects, please visit <http://www.nescent.org/science/awards.php>.

NESCent wants to hear from you!

Looking for support for a graduate student, faculty sabbatical, short-term visit or meeting? NESCent welcomes your proposals. We are looking to support innovative approaches to outstanding problems in evolutionary biology. In particular, proposals that have a clear interdisciplinary focus, or involve evolutionary



concepts in non-traditional disciplines, are strongly encouraged, as are proposals that demonstrate international participation and a mix of senior and emerging researchers, including graduate students.

NESCent is now accepting applications for short-term visitors, graduate and sabbatical fellowships, and meetings. Proposals for short-term visits are 2 weeks to 3 months. Proposals for sabbaticals may be for up to a full year. The next deadline for short-term visitors is April 1. For graduate fellowships, the next deadline is July 1. For sabbaticals, working

groups, and catalysis meetings, the next deadline is July 10.

NESCent will not support collection of new data or field research, but encourages the synthesis of existing data and information resources. NESCent is committed to making data, databases, software and other products that are developed as part of NESCent activities available to the broader scientific community.

For more information, visit nescent.org/science/proposals.php, or contact Dr. Allen Rodrigo (a.rodrido@nescent.org).

PUBLICATIONS

Recent publications by NESCent authors

Balaguer, L., R. Arroyo-García, et al. (2011). "Forest restoration in a fog oasis: evidence indicates need for cultural awareness in constructing the reference." *PLoS ONE* 6(8): e23004. doi:23010.21371/journal.pone.0023004.

Basey, J. and C. Francis (2011). "Design of inquiry-oriented science labs: impacts on students' attitudes." *Research in Science & Technological Education* 29: 241-255.

Caruso, C., H. Maherali, et al. (2012). "Why are trade-offs between flower size and number infrequently detected? A test of three hypotheses." *International Journal of Plant Sciences*. In press.

Durst, P. and L. Roth (2012). "Classification tree methods provide a multifactorial approach to predicting insular body size evolution in rodents." *American Naturalist*. In press.

Edrey, Y., D. Casper, et al. (2011). "Sustained high levels of neuregulin-1 in the longest-lived rodents; a key determinant of rodent longevity." *Aging Cell* doi:10.1111/j.1474-9726.2011.00772.x.

Edwards, E. and G. P. W. Group (2011). "New grass phylogeny resolves deep

evolutionary relationships and discovers C4 origins." *New Phytologist* doi:10.1111/j.1469-8137.2011.03972.x.

Francis, C., C. Ortega, et al. (2011). "Noise pollution filters bird communities based on vocal frequency." *PLoS ONE* 6(11): e27052. doi:27010.21371/journal.pone.0027052.

Haven, J., L. Vargas, et al. (2011). "Pervasive recombination and sympatric genome diversification driven by frequency-dependent selection in *Borrelia burgdorferi*, the Lyme disease bacterium." *Genetics* 189: 951-966.

Hunt, J. (2011). "A conceptual model for the origin of worker behaviour and adaptation of eusociality." *Journal of Evolutionary Biology* doi:10.1111/j.1420-9101.2011.02421.x.

MacLean, E., L. Matthews, et al. (2011). "How does cognition evolve? Phylogenetic comparative psychology." *Animal Cognition* doi:10.1007/s10071-011-0448-8.

Meachen-Samuels, J. (2012). "Morphological convergence of the prey-killing arsenal of sabertooth predators." *Paleobiology* 38(1).

Plotnick, R. and D. Smith (2012). "Exceptionally preserved fossil insect ears from the Eocene Green River Formation." *Journal of Paleontology* 86(1).

Rubinstein, N., A. Doron-Faigenboim, et al. (2011). "Evolutionary models accounting for layers of selection in protein-coding genes and their impact on the inference of positive selection." *Molecular Biology and Evolution* 28(12): 3297-3308.

Rubinstein, N., D. Zeevi, et al. (2011). "The operonic location of auto-transcriptional repressors is highly conserved in bacteria." *Molecular Biology and Evolution* 28(12): 3309-3318.

Stetz, J., K. Kendall, et al. (2011). "Genetic monitoring for managers: A new online resource." *Journal of Fish and Wildlife Management* 2(2): 216-219.

Winn, A., E. Elle, et al. (2011). "Analysis of inbreeding depression in mixed-mating plants provides evidence for selective interference and stable mixed mating." *Evolution* 65(12): 3339-3359.

Xie, X., W. Qiu, et al. (2011). "Accelerated and adaptive evolution of yeast sexual adhesins." *Molecular Biology and Evolution* 28(11): 3127-3137.

RESEARCH HIGHLIGHTS

Ancient crickets hint at origins of insect hearing

How did insects get their hearing? A new study of 50 million year-old cricket and katydid fossils — sporting some of the best preserved fossil insect ears described to date— helps trace the evolution of the insect ear, say researchers working at the National Evolutionary Synthesis Center.

Insects hear with help from unusual ears, said co-author Roy Plotnick of the University of Illinois at Chicago. Grasshoppers have ears on their abdomens. Lacewings have ears on their wings. The ears of the tachinid fly are tucked under the chin. “Insects have ears on pretty much every part of their body except on their head proper,” Plotnick explained.

Insects have evolved ears at least 17 times in different lineages. Plot-

“Insects have ears on pretty much every part of their body except on their head proper.”

—Roy Plotnick,
University of Illinois at Chicago

nick and co-author Dena Smith of the University of Colorado, Boulder are trying to figure out when different insects got their ears, and whether predators may have played a role.

Modern insects use their ears to tune in to each other’s chirps, trills and peeps. Think of the chorus of crickets, or the love songs of cicadas. But many species can also pick up sounds beyond the range of human hearing, such as the high-pitched sonar of night-hunting bats. Crickets, moths and other flying insects have ultrasound-sensitive hearing and can hear bats coming, diving or swerving



50 million-year-old fossil cricket from a Green River Formation fossil site in Colorado. Fine-grained lake sediment covered and buried the animals that lived there, preserving them in exquisite detail. Specimen number 45545 from the University of Colorado Museum. PHOTO COURTESY OF DENA SMITH

in midflight to avoid being eaten.

Insects that evolved such supersensitive hearing would have had a crucial survival advantage, scientists say.

“The big evolutionary trigger for the appearance of hearing in many insects is thought to be the appearance

of bats,” Plotnick said. “Prior to the evolution of bats we would expect to find ears in relatively few insects, but after that we should see ears in more insect groups,” he explained.

see **CRICKETS**, p 11



In the Media

“Darwinian medicine’s drawn-out dawn” (Science Magazine) Twenty years ago, evolutionary biologists began urging doctors to embrace evolutionary thinking to help understand why we get sick. Where are we now? NESCent Director Allen Rodrigo and colleagues review the state of evolutionary medicine at <http://bit.ly/ufMtlz>

“When birds go to town” (Science News) Urban settings offer enterprising critters new opportunities – if they can cope with the challenges. NESCent

postdoc Clinton Francis and colleagues tell the full story at <http://bit.ly/qJscVu>.

“Climate for divorce” (Science News) Temperature and precipitation may play a role in infidelity and divorce – at least, among birds, finds NESCent postdoc Carlos Botero. Read more at <http://bit.ly/rpuk7D>.

“Communal living of the insect kind” (Eurekalert) The social lives of ants, wasps and bees have long been a puzzle to scientists. How did complex insect societies – colonies ruled by a queen and many workers – come to be? Sabbatical scholar Jim Hunt has published a new model that adds to discontent with old ideas. Learn more at <http://bit.ly/tISMGu>

“Researchers failing to make raw data public” (Nature) Adherence to data-sharing policies is as inconsistent as the policies themselves, finds a new study by NESCent postdoc Heather Piwowar. Read more at <http://bit.ly/ncwIOH>.

“How drought-tolerant grasses came to be” (Eurekalert) If you ate stuffing or grain-fed turkey this Thanksgiving, give thanks to the grasses – a family of plants that includes rice, corn and wheat. Now, a new grass family tree may help scientists develop more drought-tolerant grains: <http://bit.ly/tJ4Lkq>.

“Bigger birds flee human noise” (Science Magazine) A growing body of evidence shows that man-made noise is bad for birds, but some species are harder hit than others – particularly bigger birds with low-frequency songs, finds a new study. Find out more at <http://bit.ly/spalyv>.

Also featured in the following:

“Noise pollution is driving larger birds away, study says” (Southern California Public Radio) <http://bit.ly/sH9sjM>

“Bird chatter: What’s that? I can’t hear you!” (Discovery News) <http://bit.ly/vt6Zdj>

COMINGS AND GOINGS



We were delighted to have a stellar group of researchers in residence at NESCent this fall. We wish those who will be leaving the best of luck in their next adventure, and look forward to bright things from those who remain.

From L to R: Paul Harnik, Adam Smith, Chris Caruso, Kate Hertweck, Hafiz Maherali, Tami Cruickshank, Mike Wade, Mira Han, Ilan Greenberg. Not shown: Mike Martin, Courtney Murren, Dena Smith, Doug Soltis, Pam Soltis.

CRICKETS, continued

Did insect ears get an upgrade when bats came to be? Before this study the fossil evidence for insect hearing was too poorly preserved or scantily described to know for sure.

To find out, Plotnick and Smith turned to remarkably well-preserved fossils from a series of lake deposits in Wyoming, Utah and Colorado known as the Green River Formation, where some of the earliest bats are found. Roughly fifty million years ago, fine-grained sediment covered and buried the animals that lived there and managed to preserve them in exquisite detail. “You can see every tiny feature down to the veins in their wings and the hairs on their legs,” said Smith, who has been studying Green River fossils for more than 15 years.

For this study, the researchers examined fossils from a Green River site in Colorado, focusing on crickets and katydids, which have ears on their front legs, just below their knees. The team scoured more than 500 museum drawers of Green River fossils for crickets and katydids with intact front legs, looking for evidence of ears. “You can just make them out with the naked eye,” Plotnick said. “They look like the eye of a needle.”

In crickets and katydids living today, the ear is a tiny oval cavity with a thin membrane stretched over it that



In crickets and katydids living today, the ear (show left) is a tiny oval cavity with a thin membrane stretched over it that vibrates in response to sound, much like our own eardrum. The fossil cricket ear shown on the right appears as a light-colored oval on the front leg, just below the “knee.” Specimen number 30868 from the National Museum of Natural History. PHOTO COURTESY OF ROY PLOTNICK

vibrates in response to sound, much like our own eardrum.

The fossil ears measured half a millimeter in length, and were virtually identical in size, shape, and position to their modern counterparts.

The findings suggest that this group of insects evolved their supersensitive hearing long before bat predators came to be, the researchers say. “Their bat-detecting abilities may have simply become apparent later,” Smith said.

“The next step is to look for ears in other insect groups,” she added. ●

The study appears in the January 2012 issue of Journal of Paleontology, and is available online at <http://www.psjournals.org/doi/abs/10.1666/11-072.1>.

CITATION: Plotnick, R. and D. Smith (2012). “Exceptionally preserved fossil insect ears from the Eocene Green River Formation of Colorado.” *Journal of Paleontology* 86(1): 19-24.

COMING SOON

Thinking Evolutionarily

On October 25-26, 2011, the National Research Council’s Board on Life Sciences and the National Academy of Sciences held a convocation in Washington, DC that launched a national initiative to infuse evolutionary science into introductory college courses in the life sciences and upper-level biology courses in high

schools across the United States.

The convocation arose from the NESCent working group, Evolution Across the Curriculum, and was organized by working group members and others. The goal of the meeting was to develop a strategic plan to support faculty in making evolution-

ary science a central focus of introductory biology survey courses and other courses across the life sciences curriculum.

Read more: A report on the convocation will be published in January, 2012. For more information visit nas-sites.org/thinkingevolutionarily/.

BIG BIRDS, continued

of Land Management's Rattlesnake Canyon Wildlife Area in northern New Mexico.

The region is home to thousands of natural gas wells, many of which are coupled with noisy compressors for extracting the gas and transporting it through pipelines.

The compressors are present on some wells but absent from others. The advantage of working in natural gas sites is they allow the scientists to study noise and its effects on wildlife without many of the confounding factors often associated with noisy areas like roadways or cities, such as pollution from light and chemicals or collisions with cars.

"Previous studies haven't been able to tease apart noise from all the other factors that could also affect birds," Francis said.

At noisy wells the compressors run 24 hours a day, 365 days a year. The constant roar and rumbling is about 80 decibels — as loud as a motorcycle less than 50 feet away.

The researchers surveyed birds at noisy sites with compressors and quiet sites without them. For each species in their study — 30 species including the black-chinned hummingbird, common poorwill, pinyon jay and western scrub jay — they also recorded its song using a shotgun microphone.

Species with low frequency songs were less likely to defend territories or build nests near noisy machinery, the researchers report. "Some species are opting not to breed in these areas, and others aren't going there at all," Francis said.

These birds may be forced out of noisy



A new study finds that large birds with low-frequency songs – such as the mourning doves pictured here – are less likely to nest near noisy sites.

sites because they can't hear each other over the din, he added. Most anthropogenic noise is lower-frequency and more constant than noise found in nature. "Species whose songs overlap with the frequency range of man-made noise

"Bigger birds sing at frequencies that are more easily masked by the low frequencies typical of human noise pollution."

—Clinton Francis, NESCent

should be more sensitive," Francis said.

Worst hit were bigger birds such as the western tanager, black-headed grosbeak and mourning dove, because large birds sing lower songs that are more likely to be drowned out.

"The results were surprising because larger birds are also typically louder," Francis said. Despite singing at higher volumes than their smaller cousins,

bigger birds with deeper voices are still harder hit.

Smaller, higher singers such as the chipping sparrow and the house finch stayed behind, presumably because their higher ballads stand out better.

The phenomenon may be aggravated by the fact that bigger birds also have larger territories, which means their songs have to span a larger area.

For Francis and his team, the next step is to compile bird data from roughly two hundred species living in other types of noisy sites to see if they show the same pattern. "This may not be restricted to oil and gas lands in New Mexico. We'd like to know if we see the same trend in response to city and traffic noise, and man-made noise more generally," Francis said. ●

CITATION: Francis, C., C. Ortega, et al. (2011). "Noise pollution filters bird communities based on vocal frequency." PLoS ONE 6(11): e27052.