@NESCent

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.

SEPTEMBER 2009 | VOLUME 1 No. 1 | www.nescent.org

IN THIS ISSUE:

Research Highlights	1,2,3
New Arrivals	3
Call for Proposals	3
Latest Happenings	4
Upcoming Events	4,5
Recent Publications	5

Fossil teeth of *Megapiranha paranensis* help explain how piranhas got their distinctive bite. **P2**

ABOUT NESCENT:

NESCent is an NSF-funded collaborative research center operated by Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University. For more information about research and training opportunities at NESCent, visit **http://www.nescent.org**.

SENIOR LEADERSHIP:

Kathleen Smith, Director

Joel Kingsolver, Associate Director of Science and Synthesis

Todd Vision, Associate Director of Informatics

Brian Wiegmann, Associate Director of Education and Outreach

RESEARCH HIGHLIGHTS

The evolutionary fate of 'useless' traits

What happens when traits no longer give creatures a competitive edge? Some subterranean animals that live in darkness function perfectly well without eyesight, for example. And the tiny leg bones buried in the backs of whales – left over from their land-dwelling ancestors – don't get much action in the ocean.

> "All traits will eventually disappear if they have no function. The question we're asking now is: how do you know how fast that will happen?" –David Lahti

Moles and many other subterranean animals that live in darkness have eyes that have diminished or even disappeared over evolutionary time. PHOTO BY MICHAEL DAVID HILL, WIKIPEDIA

In a recent review, researchers teamed up to take a closer look at the evolutionary fate of useless traits. Supported by a working group award from NESCent, their aim was to examine what happens to traits that are no longer needed. "Just about everybody who thinks about trait evolution focuses on traits that are beneficial," writes first author David Lahti, a biologist at Queens College. "But few people think about traits that are useless, or that are becoming less useful over time."

For example, the ability to recognize and flee from enemies becomes less critical in predator-free habitats. "There are many examples of animals that were once subject to predation, but have since been introduced to areas where predators are absent or have been killed off," Lahti says. In these cases, studies show that traits which were once key to survival – vigilance, caution, speed and agility – start to erode over time. "Things like alertness, having to run fast, having to fly – traits of predator avoidance end up being useless to these animals," Lahti says.

Under an evolutionary phenomenon called relaxed selection, traits that were advantageous in one time and place become obsolete in another. Traits that aren't actively maintained by selection tend to become smaller or less functional over time, studies suggest. The researchers wanted to know why some traits break down quickly, while others take longer to go away. "All traits will eventually disappear if they have no function," Lahti explains. "The question

see USELESS, p6

New fossil tells how piranhas got their teeth

An international team of researchers uncover a jawbone that sheds some light on the bite

How did piranhas – the legendary freshwater fish with the razor bite – get their telltale teeth? Researchers from Argentina, the United States and Venezuela have uncovered the jawbone of a striking transitional fossil that sheds light on this question. Named *Megapiranha paranensis*, this previously unknown fossil fish bridges the evolutionary gap between flesh-eating piranhas and their plant-eating cousins.

Present-day piranhas have a single row of triangular teeth, like the blade on a saw, explained the researchers. But their closest relatives – a group of fishes commonly known as pacus – have two rows of square teeth, presumably for crushing fruits and seeds. "In modern piranhas the teeth are arranged in a single file," said Wasila Dahdul, a visiting scientist at the National Evolutionary Synthesis Center in North Carolina. "But in the relatives of piranhas – which tend to be herbivorous fishes – the teeth are in two rows," said Dahdul.

Megapiranha shows an intermediate pattern: it's teeth are arranged in a zig-zag row. This suggests that the two rows in pacus were compressed to form a single row in piranhas. "It almost looks like the teeth are migrating from the second row into the first row," said John Lundberg, curator at the Academy of Natural Sciences in Philadelphia and a co-author of the study.

If this is so, *Megapiranha* may be an intermediate step in the long process that produced the piranha's distinctive bite. To find out where *Megapiranha* falls in the evolutionary tree for these fishes, Dahdul examined hundreds of specimens of modern piranhas and their relatives. "What's cool about this group of fish is their teeth have really distinctive features. A single tooth can tell you a lot about what species it is and what other fishes they're related to," said Dahdul. Her phylogenetic analysis confirms their hunch – *Megapiranha* seems to fit between piranhas and pacus in the fish family tree.

see PIRANHA, p6

"What's cool about this group of fish is their teeth have really distinctive features. A single tooth can tell you a lot about what species it is and what other fish they're related to." – Wasila Dahdul, visiting scientist at NESCent

The zig-zag teeth of *Megapiranha paranensis* are intermediate between the single row of teeth in piranhas and the double row in their plant-eating cousins. PHOTO COURTESY OF MARK SABAJ-PEREZ

OPPORTUNITIES

Call for Proposals

Looking for funding for a sabbatical, postdoc, or meeting? Since its beginnings in 2004, more than 3,000 scientists have turned to NESCent for research funding in evolutionary biology. Find out how you can take advantage of what NESCent has to offer.

NESCent is now accepting applications for postdoctoral and sabbatical fellowships, short-term visitors, and meetings. The next deadline for postdoctoral and sabbatical fellowships and catalysis meetings is December 1. For short-term visitors, the deadline is January 1.

To learn more about funding opportunities at NESCent, visit our website at **www.nescent.org**

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 **http://www.nescent.org/about/employment.php**

Stay Informed

Subscribe to the NESCent email newsletter to receive news about funding, 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, visit: **https://lists.nescent.org/mailman/options/news** You can also visit NESCent on **Twitter**, **Facebook**, and **YouTube**.

RESEARCH HIGHLIGHTS

Student software developers showcase their work

For the third summer in a row, NESCent offered a number of student internships aimed at expanding participation in collaborative open-source software development projects.

Interns from around the world were given the opportunity to work remotely on an evoinformatics project of their own choosing, each under the guidance of an experienced mentor.

This summer, NESCent received funding for 9 students from the Google Summer of CodeTM program, and an additional four from the NSF Virtual Data Center project. As their profiles demonstrate, the students put their summers to very good use! To meet the students and learn more about their projects, visit **http://hackathon.nescent.org/Phyloinformatics_Summer_of_Code_2009/Summaries** ●

NEW ARRIVALS

NESCent is pleased to welcome the following new arrivals:

Jim Hunt joined NESCent as a sabbatical scholar from North Carolina State University. Jim plans to use his sabbatical to write a book on the evolution of animal societies, from ant colonies to schools of fish. **Read more: http://www.nescent.org/science/awards_summary.php?id=188**

Benjamin Redelings moved to NESCent from a postdoctoral position in bioinformatics at North Carolina State University. Ben will extend his work on phylogenetic software by improving methods for handling insertion/deletion hotspots in DNA sequence data. **Read more: http://www.nescent.org/science/awards_summary.php?id=183**

Liam Revell is interested in developing new methods for analyzing phylogenetic trees. While a postdoc at NESCent, Liam will use these methods to test hypotheses about the evolutionary processes underlying the diversification of species. Liam moved to NESCent from Harvard University. **Read more: http://www.nescent.org/science/awards_summary.php?id=184**

Michael Rosenberg is a sabbatical scholar from Arizona State University. While at NESCent, Mike aims to merge the disciplines of landscape genetics and phylogeography, two fields which focus on similar questions but deal with divergent scales of time and space. **Read more: http://www.nescent.org/science/awards_summary.php?id=189**

New arrivals from L to R: Liam Revell, Julie Meachen-Samuels, Gregor Yanega, Eric Schuettpelz, Ben Redelings, Jim Hunt

Eric Schuettpelz will combine DNA and fossil data from vascular plants to examine the origin of modern tropical rain forests. Formerly a PhD student at Duke University, Eric joined NESCent as a postdoctoral fellow in August 2009. **Read more: http://www.nescent.org/science/awards_summary.php?id=186**

Gregor Yanega joined NESCent from the University of Connecticut in August 2009. Gregor will use his postdoctoral fellowship to compare island birds with their mainland counterparts using phylogenetic comparative methods. **Read more: http://www.nescent.org/science/awards_summary.php?id=187**

LATEST HAPPENINGS

NESCent launches teacher workshop

NESCent offered its first on-site teacher workshop from June 29 through July 2. Fifteen high school science teachers from across North Carolina attended the workshop. The workshop included talks by practicing researchers, discussions of common misconceptions about evolution, hands-on classroom activities, and a tour of the Duke Lemur Center. At the end of the workshop, participants developed lesson plans to use in their classrooms and share with colleagues. For access to workshop content, activities, and participant-generated lesson plans, visit **http://www.nescent.org/courses/2009/eogsummer_resources_2009.php.**

Meta-analysis course a success

NESCent offered a week-long introduction to meta-analysis in July. Nearly two dozen graduate students, postdocs and faculty participated. The course focused on what meta-analysis is, how it is used in ecology and evolution, and its major strengths and weaknesses as a tool for the quantitative summary of research results. The students gathered data from the scientific literature to perform their own preliminary meta-analysis, and learned how to interpret, evaluate and critique the results. Lectures, demonstrations, and hands-on computer labs were led by Jessica Gurevitch (Stony Brook University), Kerrie Mengersen (Queensland University of Technology) and Marc Lajeunesse (NESCent).

Interested in training opportunities at NESCent? For information about future courses please contact Jory Weintraub, Education and Outreach Program Manager, at **jory@nescent.org.**

UPCOMING EVENTS

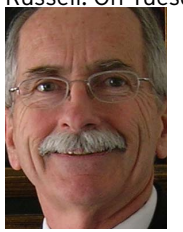
Darwin Lecture Series

What: free public lecture

When: September 29, 2009, 6:30pm

Where: North Carolina Museum of Natural Sciences, Raleigh

Learn about the evolution of life on land with North Carolina paleontologist Dale Russell. On Tuesday, September 29, Russell will present a talk based on his new book *Islands in the Cosmos: The Evolution of Life on Land*. Signed copies of the book will be available. The talk begins at 6:30 p.m. at the North Carolina Museum of Natural Sciences in downtown Raleigh.



DALE RUSSELL

Seating is on a first come, first served basis. Doors to the Museum and auditorium will open at 6 p.m. Please RSVP to museum.reservations@ncmail.net. Admission is free. For more information visit: **http://naturalsciences.org/about-us/news/?select=1146**

About the series: The Darwin Lecture Series is one of many events planned in 2009 to commemorate the bicentennial of Charles Darwin's birth and the 150th anniversary of the publication of "The Origin of Species." On November 24, the final lecture in the series will feature paleontologist Paul Brinkman speaking on "Charles Darwin's Beagle Voyage and the Origin of 'The Origin'."

Supporting Chicano and Native American scientists

What: SACNAS national conference

When: October 15-18, 2009

Where: Dallas, TX

In what has become one of NESCent's main minority outreach events, we will once again have a strong presence at the annual meeting of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS). As we do each year, we will be partnering with several other organizations to put together a suite of activities focusing on evolution and ecology, including a career mentoring session, a scientific symposium, a field trip, and our annual movie night.

This year's movie will be the Nova special "Judgment Day: Intelligent Design on Trial" and will include a discussion led by Dr. Rob Pennock, a former NESCent sabbatical scholar who served as an expert witness in the 2005 Dover trial. The goal of these activities is to expose underrepresented minority students to ecology and evolution and to excite them about pursuing careers in these fields.

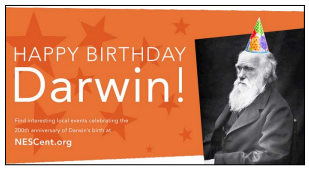
Play brings Darwin's letters to life

What: "Re: Design"

When: November 4-8, 2009

Where: Thompson Hall Theater at North Carolina State University, Raleigh (link)

Mark your calendars for a theatrical reenactment of the life of Charles Darwin, as revealed through his friendship with botanist Asa Gray. Playwright Craig Baxter brings Darwin and his lifelong ally to life in a play coming this fall to North Carolina State University.



NESCent is co-sponsoring the event with the NC Museum of Natural Sciences, WUNC-TV, and NCSU. The production will be staged in the newly renovated Thompson Hall Theater, and will run for five days from Nov. 4th to Nov. 8th.

At the conclusion of the opening performance on Wed. Nov. 4, NESCent has organized a panel discussion to explore Darwin's legacy in science and society. The panel will include Dr. Jim Costa (Professor at Western Carolina University and author of an annotated version of The Origin of Species) and Dr. Will Kimler (NCSU Professor and noted Darwin Scholar), as well as one or two other evolutionary biologists/Darwin scholars.

The first performance (Wed. Nov. 4) will start at 7pm, the 2nd, 3rd, and 4th performances (Thurs-Sat) will start at 8pm, and the final performance (Sunday, Nov. 8) will be a 3pm matinee. All tickets $10 general public; NCSU students $5. To purchase tickets visit **http://www.ncsu.edu/theatre/currentseason.html.**

Evolution symposium at teachers conference

What: National Association of Biology Teachers 2009 conference (link)

When: November 11-14, 2009

Where: Denver, CO

In November, NESCent and AIBS will present their annual evolution symposium at the conference of the National Association of Biology Teachers (NABT) in Denver, CO. This year's symposium will feature talks by four scientists who study evolution in extreme environments, from high altitudes, to the deep sea, to caves and ice.

Participants will also receive a CD-ROM containing activities, film clips and learning modules focused on evolution in extreme environments. Following the half-day symposium, educators from NESCent, California State University at Los Angeles and the Understanding Evolution website will lead a workshop on evolution in the arid desert.

UPCOMING EVENTS

Calling all biology instructors!

Now recruiting classroom field testers for 'Evo in the News' podcast program

Looking for recent case study in evolutionary biology to share with your students?

NESCent joins forces with the University of California Museum of Paleontology to produce a monthly "Evo in the News" story and podcast. These pieces are based on science articles in the popular press and include descriptions of key concepts, additional reading, and supporting classroom activities.

We are recruiting high school and college biology instructors to participate in an assessment of the Evo in the News program.

The assessment involves using an Evo in the News story and podcast with your students, administering a short online test, and completing an instructor survey.

If you are teaching a biology course in the fall semester and would like to participate, please email Kristin Jenkins at **kjenkins@nescent.org**.

"Evo in the News" stories and podcasts may be viewed on the **website**, **Understanding Evolution** site, **NESCent's YouTube page**, or downloaded from **iTunes U**.

RECENT PUBLICATIONS

Recent publications by NESCent authors

Cione, A., **W. Dahdul**, et al. (2009). "Megapiranha paranensis, a new genus and species of Serrasalmidae (Characiformes, Teleostei) from the upper Miocene of Argentina." Journal of Vertebrate Paleontology 29(2): 350-358.

Collar, D. C., **B. C. O'Meara**, et al. (2009). "Piscivory limits diversification of feeding morphology in centrarchid fishes." Evolution 63(6): 1557-1573.

Dahdul, W. M., P. M. Mabee, et al. (2009). "The Teleost anatomy ontology: anatomical representation for the genomics age." Systematic Biology. In press.

Hazkani-Covo, E. (2009). "Mitochondrial insertions into primate nuclear genomes suggest the use of numts as a tool for phylogeny." Molecular Biology and Evolution. doi: 10.1093/molbev/msp131

Kimmel, C. B., **B. Sidlauskas**, et al. (2009). "Linked morphological changes during palate evolution in early tetrapods." Journal of Anatomy 215(2): 91-109.

Lahti, D. C., N. A. Johnson, et al. (2009). "Relaxed selection in the wild." TREE 24(9): 487-496.

Lajeunesse, M. A. (2009). "Meta-analysis and the comparative phylogenetic method." The American Naturalist 174(3): 369-381.

McClain, C. and J. P. Barry (2009). "Habitat heterogeneity, biogenic disturbance, and resource availability work in concert to regulate biodiversity in deep submarine canyons." Ecology. In press.

Meachen-Samuels, J. and W. Binder (2009). "Sexual dimorphism and ontogenetic growth in the American lion (Panthera atrox) and sabertoothed cat (Smilodon fatalis) from Rancho La Brea." Journal of Zoology. In press.

Meachen-Samuels, J. and B. Van Valkenburgh (2009). "Forelimb indicators of prey-size preference in the Felidae." Journal of Morphology 270(6): 729-744.

Revell, L. (2009). "Size-correction and principal components for interspecific comparative studies." Evolution. In press.

Roberts, T. E., E. J. Sargis, et al. (2009). "Networks, trees, and treeshrews: assessing support and identifying conflict with multiple loci and a problematic root." Systematic Biology 58(2): 257-270.

Samuels, J. X., **J. A. Meachen-Samuels**, et al. (2009). "The first Mid-Blancan occurrence of Agriotherium (Ursidae) in North America: a record from Hagerman Fossil Beds National Monument, Idaho." Journal of Paleontology 83(4): 597-603.

Smith, S. A. (2009). "Taking into account phylogenetic and divergence-time uncertainty in a parametric biogeographical analysis of the Northern Hemisphere plant clade Caprifolieae." Journal of Biogeography.

Spaeth, P. A., M. van Tuinen, et al. (2009). "Phylogeography of Microtus longicaudus in the tectonically and glacially dynamic central Rocky Mountains." Journal of Mammalogy 90(3): 571–584.

Wiegmann, B., M. Trautwein, et al. (2009). "Nuclear genes resolve phylogeny of the holometabolous insect orders." BMC Biology 7(34).

USELESS, continued

we're asking now is: how do you know how fast that will happen?"

To answer this question, the researchers scoured the literature for examples of relaxed selection. After reviewing more than 80 studies spanning nearly 150 years of research, they pinpointed several factors that determine how quickly traits are lost. "Not all the same evolutionary rules are followed when you're losing a trait as when you're gaining it," Lahti says.

> "Modern technology insulates us from selection in many ways. It's a valid question to ask what the effects of this are likely to be." –David Lahti

Traits that are energetically expensive to develop or maintain tend to be phased out more quickly, they found. The threespine stickleback, for instance, is a little fish that evolved body armor to help protect itself from predators. Sticklebacks require a lot of energy and minerals to build armor, Lahti explains. When these fish are introduced to predator-free lakes where their bony plates aren't needed anymore, individuals that avoid wasting valuable energy on useless body armor fare better over time. The result? Populations that are safe from predators lose their armor over the generations. "The biggest reason why a trait goes away quickly is because it's costly," Lahti says.

Rapid trait loss is also more likely when it involves relatively simple genetic changes, studies reveal. For example, many cave-dwelling creatures such as crickets and cavefish lose their eyesight as they adapt to life in the dark. "Until very recently, we didn't know anything about the genetics or development of eyes in cave fish," Lahti explains. "People assumed it happened in successive small steps, over a long period of time." But recent research on the genetics of eye development in these animals suggests that a small number of genes play a big role in blindness. "Until modern genetic techniques we never would have guessed that these big changes in the eyes could happen by such minor genetic changes," Lahti says.

By studying relaxed selection in plants and animals in the wild, the authors hope to understand the consequences for humans as well. Advances in medicine and technology shelter humans from many sources of selection that acted in the past, Lahti explains. This might allow other traits that were helpful to our ancestors to fade away over time. "Modern technology insulates us from selection in many ways," Lahti says. "It's a valid question to ask what the effects of this are likely to be."

Collaborators on the study include Norman Johnson, Beverly Ajie, Sarah Otto, Andrew Hendry, Daniel Blumstein, Richard Coss, Kathleen Donohue, and Susan Foster.

The team's findings were published in the September 2009 issue of Trends in Ecology and Evolution (TREE). ●

CITATION: Lahti, D. C., N. A. Johnson, et al. (2009). "Relaxed selection in the wild." TREE 24(9): 487-496. doi: 10.1016/j.tree.2009.03.010

Artist's rendering of *Megapiranha paranensis*. ARTWORK BY RAY TROLL, 2005.

PIRANHA, continued

The *Megapiranha* fossil was originally collected in a riverside cliff in northeastern Argentina in the early 1900s, but remained unstudied until paleontologist Alberto Cione of Argentina's La Plata Museum rediscovered the startling specimen – an upper jaw with three unusually large and pointed teeth – in the 1980s in a museum drawer.

Cione's find suggests that *Megapiranha* lived between 8-10 million years ago in a South American river system known as the Paraná. But you wouldn't want to meet one today. If the jawbone of this fossil is any indication, *Megapiranha* was a big fish. By comparing the teeth and jaw to the same bones in present-day species, the researchers estimate that *Megapiranha* was up to 1 meter (3 feet) in length. That's at least four times as long as modern piranhas. Although no one is sure what *Megapiranha* ate, it probably had a diverse diet, said Cione.

Other riddles remain, however. "Piranhas have six teeth, but *Megapiranha* had seven," said Dahdul. "So what happened to the seventh tooth?"

"One of the teeth may have been lost," said Lundberg. "Or two of the original seven may have fused together over evolutionary time. It's an unanswered question. Maybe someday we'll find out."

The team's findings were published in the June 2009 issue of the Journal of Vertebrate Paleontology. ●