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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.

IN THIS ISSUE:

NEXT PROPOSAL DEADLINES:

July 1: graduate fellowships, short-term visitors

July 10: sabbaticals, catalysis meetings, journalists-in-residence, course proposals

Sept. 1: short-term visitors

For more information, turn to page 3

Don't miss these exciting events at Evolution 2013 in Snowbird, Utah:

Fri. June 21: Attend a workshop on teaching evolution to undergraduates

Sun. June 23: Vote on your favorite evolution videos at the NESCent Evolution Film Festival

Tues-Wed. June 25-26: Participate in the 4th annual iEvoBio conference on evolutionary informatics

For more information turn to page 4

evolution 2014

Raleigh Convention Center, North Carolina, June 20-24, 2014

RESEARCH HIGHLIGHTS

The Amhara people have inhabited mountainous regions of Ethiopa for thousands of years.

Ethiopians and Tibetans thrive in thin air using similar physiology, different genes

Scientists say they have pinpointed genetic changes that allow some Ethiopians to live and work more than a mile and a half above sea level without getting altitude sickness. The specific genes differ from those reported previously for high-altitude Tibetans, even though both groups cope with low-oxygen in similar physiological ways, finds a study in the journal PLOS Genetics.

If confirmed, the results may help scientists understand why some people are more vulnerable to low blood oxygen levels caused by factors other than altitude — such as asthma, sleep apnea, heart problems or anemia — and point to new ways to treat them. The study adds to our understanding of how high-altitude populations worldwide have evolved to be different from their low-altitude ancestors, the researchers say.

Living with less

Lower air pressure at high altitude means fewer oxygen molecules for every breath. "At 4000 meters, every lungful of air only has 60% of the oxygen molecules that people at sea level have," said NESCent researcher Cynthia Beall of Case Western Reserve University.

To mop up scarce oxygen from thin air,

see THIN AIR, p 8

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.**

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Uncovering Africa's oldest known penguins

Africa isn't the kind of place you might expect to find penguins. But one species lives along Africa's southern coast today, and newly found fossils confirm that as many as four penguin species coexisted on the continent in the past. Exactly why African penguin diversity plummeted to just one species is still a mystery, but changing sea levels may be to blame, the researchers say.

The fossil findings represent the oldest evidence of these iconic tuxedo-clad seabirds in Africa, predating previously described fossils by 5 to 7 million years.

Co-authors Daniel Thomas of the National Museum of Natural History and Dan Ksepka of the National Evolutionary Synthesis Center happened upon the 10-12 million year old specimens in late 2010, while sifting through rock and sediment excavated from an industrial steel plant near Cape Town, South Africa.

Jumbled together with shark teeth and other fossils were 17 bone fragments the researchers recognized as pieces of backbones, breastbones, wings and legs from several extinct species of penguins.

Based on their bones, these species spanned nearly the full size spectrum for penguins living today, ranging from a runty pint-sized penguin that stood just about a foot tall (0.3 m), to a towering species closer to three feet (0.9 m).

Only one penguin species lives in Africa today – the endangered black-footed penguin, or Spheniscus demersus. But newly found fossils confirm that as many as four penguin species coexisted on the continent in the past. PHOTO BY DANIEL THOMAS.

Only one penguin species lives in Africa today — the black-footed penguin, or Spheniscus demersus, also known as the jackass penguin for its loud donkey-like braying call. Exactly when penguin diversity in Africa started to plummet, and why, is still unclear.

Gaps in the fossil record make it difficult to determine whether the extinctions were sudden or gradual. "[Because we have fossils from only two time periods,] it's like seeing two frames of a movie," Ksepka said. "We have a frame at five million years ago, and a frame at 10-12 million years ago, but there's missing footage in between."

Humans probably aren't to blame, the researchers say, because by the time early modern humans arrived in South Africa, all but one of the continent's penguins had already died out.

A more likely possibility is that rising and falling sea levels did them in by wiping out safe nesting sites.

Although penguins spend most of their lives swimming in the ocean, they rely on offshore islands near the coast to build their nests and raise their young. Land surface

see PENGUINS, p 7

COMING SOON

Beef up your evolutionary toolbox

Register now for summer courses from the NESCent Academy

Interested in hands-on training workshops in evolutionary biology? Act fast: Applications will soon close for the following NESCent Academy courses for summer 2013. Graduate students, postdoctoral fellows and junior faculty members are eligible to apply.

Next-generation sequencing data for phylogenetics and phylogeography

When: June 3-9, 2013

Where: Durham, NC

Application review begins: April 1

The rapid expansion of genomic resources and explosion of new genome sequencing technologies allows researchers to obtain large phylogenomic data sets for any system rapidly and economically. In this course, students will receive an overview of recent technological advances, learn about data collection using emerging phylogenomic approaches, and analyze data sets using the most recent methods. Areas to be covered include: (1) emerging sequencing technologies, (2) targeted high-throughput sequencing approaches, such as anchored phylogenomics, transcriptome sequencing, reduced-representation library sequencing/ RAD sequencing, and high-throughput amplicon sequencing, and (3) data analysis, including phylogenetic and phylogeographic analysis, and species delimitation.

INSTRUCTORS: Alan Lemmon & Emily Moriarty Lemmon (Florida State), Cecilé Ané (U. of Wisconsin-Madison), Jeremy Brown (Louisiana State), Frank Burbrink (College of Staten Island/ CUNY), Seth Bybee (Brigham Young), Laura Kubatko (Ohio State), David Weisrock (U. of Kentucky)

HOW TO APPLY: Application review began April 1. For more info and a link to the application, visit **bit.ly/13K8JtI**.

Generic Model Organism Database (GMOD) Summer School

When: July 19-23, 2013

Where: Durham, NC

Application review begins: June 10

The Generic Model Organism Database (GMOD) project provides free, open-source, interoperable software packages for visualization, storage, and dissemination of genetic and genomic data. The GMOD Summer School is a five-day course that covers the installation and usage of a number of widely used GMOD components, including the configuration of tools for different server and data types, and setting up a database with a Chado schema. The course is taught by members of the software development teams, who are all experienced developers, and GMOD project staff. The course comprises a set of hands-on tutorials; most sessions are four hours long (a half day), and the evenings feature work sessions where the instructors are available to answer questions and help participants use the tools with their data.

INSTRUCTORS: Scott Cain (GMOD, GBrowse, Chado), Dave Clements (Galaxy), Sheldon Mackay (GBrowse synteny browser), Rob Buels (JBrowse), Barry Moore (MAKER), Stephen Ficklin (Tripal), Ed Lee (Web Apollo)

HOW TO APPLY: Application review begins June 10. For more info and a link to the application, visit **bit.ly/Yhpz1F**.

Ontologies for evolutionary biology

When: July 29-August 3, 2013

Where: Durham, NC

Application review begins: June 1

Evolutionary research has been revolutionized by the explosion of genetic information available, and ontologies must play a central role in relating this knowledge to observable diversity. Ontologies provide scaffolding that interconnects many kinds of observations; across species, they provide evolutionary, developmental, and mechanistic insights. In this course, we will discuss the integration points between ontologies including anatomy, phenotype, ecology, and biodiversity efforts; on partnerships between domain experts and expert ontologists; and on descriptions of various tools and tricks to handle ontologies and ontology-annotated data in the context of evolutionary biology.

INSTRUCTORS: Melissa Haendel, Matt Yoder, Jim Balhoff, Erik Segerdell

HOW TO APPLY: Application review begins June 1. For more info and a link to the application, visit **bit.ly/ZAQ6Dt**.

Evolutionary quantitative genetics

When: August 5-10, 2013

Where: Durham, NC

Application review begins: May 20

Quantitative genetics deals with the inheritance of measurements of traits that are affected by many genes. Developments in the field are not reflected in textbooks and available courses aimed at evolutionary biologists. This workshop will review the basics of theory in the field of evolutionary quantitative genetics, its connections to evolution that is observed at various time scales and illustrate how that theory can be tested with data. Participants will learn to use R, an open-source statistical programming language, to build and test evolutionary models.

INSTRUCTORS: Steve Arnold, Joe Felsenstein, Thomas Hansen, Trudy Mackay, Brian O'Meara, Patrick Phillips, Liam Revell, Josef Uyeda

HOW TO APPLY: Application review begins May 20. For more info and a link to the application, visit **bit.ly/ngFq5y**.

Proposing a course

Got an idea for an evolution-related course that you want to teach? NESCent welcomes proposals for short 1-2 week courses at the postgraduate level. NESCent provides the venue, budget and logistics support, allowing PIs to focus on the syllabus and format. The deadline for course proposals is July 10 of each year: **bit.ly/MASFBP**.

THE PREMIER INTERNATIONAL CONFERENCE OF EVOLUTIONARY BIOLOGISTS

Sign up for a workshop on teaching evolution to undergrads

WHERE: Snowbird Conference Center

WHEN: Friday, June 21
8:30 a.m. - 5 p.m.

Evolution is a key biological concept, but it is also a very challenging topic to teach. Join us for a day focused on effective methods and tools for teaching evolution. Designed for future and current faculty, this workshop will cover national movements to improve undergraduate biology education, evolution resources to use in the classroom, information on how students learn evolutionary concepts, and more. $25 registration fee includes lunch, as well as a collection of materials for teaching evolution. Sign up for the workshop by paying the $25 fee when you register for Evolution 2013 on the main conference registration site. Limited to 30 participants. For more information visit **bit.ly/154unuC** or contact Louise Mead (lsmead@msu.edu), Jamie Jensen (jamie.jensen@byu.edu) or Kristin Jenkins (kjenkins@nescent.org).

EVOLUTION 2013

Ready for some REEL science?

WHERE: Snowbird Conference Center

WHEN: Sunday June 23
9:00-10:15 p.m.

View and vote on your favorite 3-min. videos at the 3rd annual NESCent Evolution Film Festival. Contestants were challenged to submit an entertaining and informative video that explains a fun fact, key concept, compelling question, or exciting area of evolution research in three minutes or less. Come to the festival to view and vote on your favorite films. Winners will be announced at the awards reception on Tuesday June 25. To find out more, stop by the NESCent booth or visit **bit.ly/IxKns1**.

Tracking the trail of big data

Join us for the 4th annual iEvoBio conference on evolutionary informatics

WHERE: Snowbird Conference Center

WHEN: Tues.-Wed. June 25-26
8 a.m. - 5 p.m.

Are you interested in the intersection of biology, software, and mathematics? Come to the iEvoBio Meeting on June 25-26, in conjunction with Evolution 2013 in Snowbird, Utah!

The iEvoBio Meeting brings together biologists working in evolution, systematics and biodiversity with software developers and mathematicians.

You can participate by giving a 5-minute lightning talk on a method, idea, or software product about bioinformatics, by demonstrating your open-source software product, or by joining a "birds of feather" group, an informal group of meeting participants with a common interest.

You'll also see talks by two fabulous keynote speakers, Drs. Holly Bik (**hollybik.com/**) and Heather Piwowar (**researchremix.org/**)

You can register for iEvoBio alone or together with the main meeting. Get the latest program details, find answers to frequently asked questions, and more at **ievobio.org/**

SAVE THE DATE!

Mark your calendars for **Evolution 2014**, to be held in Raleigh, North Carolina, June 20-24, 2014. NESCent is pleased to host the conference, in collaboration with faculty from the wider academic community in North Carolina. Stop by the NESCent booth for more info. We hope to see you there.

NEW AWARDS

Grad students win travel awards to attend the "World Congress on Evolution III"

Congratulations to the two outstanding graduate students who were selected for travel awards to attend the third "World Congress on Evolution," to be held June 1-5, 2013, on the Galapagos Island of San Cristobal.

Melissa Kemp is a third-year PhD student in Elizabeth Hadly's lab at Stanford University, and Aide Macias Muñoz is a first-year PhD student from Adriana Briscoe's lab at UC Irvine.

The awards will cover conference registration, travel, food and lodging. As part of NESCent's efforts to serve members of groups that are under-represented or under-served in evolutionary science, the awards were restricted to graduate students who identify as American Indian/Alaska Native, Asian, Black/African American, Hispanic/Latino/Latina, and/or Native Hawaiian/Other Pacific Islander.

Forty-two students applied. Our only regret is that we have funds to send just two of them. Congrats again to Melissa and Aide!

AWARDS

Congratulations to the newest award recipients for 2013

NESCent is pleased to announce the following new awards:

WORKING GROUPS

Michael Gavin (Colorado State University) *Explaining cultural diversity: a new evolutionary synthesis*

Susan Kalisz (University of Pittsburgh) *Linking self-fertilization, dispersal and distribution traits of species: Is Baker's law an exception to the rule?*

Cynthia Riginos (The University of Queensland) *Advancing genetic diversity research in the Indian and Pacific Oceans*

Mary Shenk (University of Missouri) *Integrating evolutionary models of human fertility change*

LONG-TERM SABBATICAL SCHOLARS

Jeffrey Conner (Michigan State University) *Synthesizing data on natural selection and genetics across multiple scales*

Uri Gophna (Tel-Aviv University) *Do microbial immune systems reduce lateral gene transfer in prokaryotic genomes?*

SHORT-TERM VISITORS

Christina Caruso (University of Guelph) *Gynodioecy and the evolution of separate sexes in the flowering plants*

Jeremy Chase Crawford (University of California, Berkeley) *Bridging ontogeny, mechanism, and function in the study of complex animal signals*

Lynn Fellman (Fellman Studio) *Visions of Neanderkin: comparing ancient and modern genomes through art and narrative*

Hafiz Maherali (University of Guelph) *Exploring ecological and evolutionary causes of the plant-fungal symbiosis*

C. Tristan Stayton (Bucknell University) *Tools for measuring the magnitude and significance of convergent evolution*

Brandon Routman *Explaining the framing effect through evolutionary analysis*

GRADUATE FELLOWS

Meghan Balk (University of New Mexico) *Predator-prey interactions: drivers of mammalian body size evolution*

Heath Blackmon (University of Texas, Arlington) *Comprehensive analysis of the rates and patterns of sex chromosome evolution in arthropods*

Michael Landis (University of California, Berkeley) *Bayesian model testing of Bergmann's Rule on mammalian biogeography*

Matthew Wilkins (University of Colorado, Boulder) *Factors shaping acoustic signal evolution and implications for decision-making contexts*

JOURNALISTS-IN-RESIDENCE

Rebecca Searles (The Huffington Post) *Applied evolutionary psychology and the future of human evolution*

Lynn Fellman (Fellman Studio) *I am a Multi. An iBook about human genetic ancestry*

Carrie Arnold (freelance) *Our microbial minds: how microbes make us human*

TRIANGLE SCHOLARS

Kathleen Donohue (Duke University) *How genetics pathways influence organismal responses to climate change*

Andrea Taylor (Duke University) *Big mouths or strong bites: what drives the evolution of the feeding apparatus in primates?*

EVOLUTION 2013 TRAVEL AWARDS FOR FACULTY FROM MINORITY-SERVING INSTITUTIONS

Yonas Tekle (Spelman College)

Elizabeth Torres (California State University, Los Angeles)

UNDERGRADUATE DIVERSITY AT EVOLUTION TRAVEL AWARDS

Bianca Brown (CUNY York College)

Jason Bundy (Pennsylvania State University)

Joseph Cauceglia (University of Utah)

PangKou Chang (University of California, Merced)

Jessica Coates (Spelman College)

Nena Cole (Portland State University)

Emily Geest (University of Missouri- St. Louis)

Domonique Hatton (Spelman)

Devon Humphreys (University of Georgia)

Cierra Keith (Oklahoma State University)

Karoline Lake (Barnard College)

Shanna Newton (California State University, Long Beach)

Devin O'Brien (University of Connecticut)

Julio Ramirez (University of Kansas)

Victoria Rodriguez (Texas A&M University)

Riley Smith (San Francisco State University)

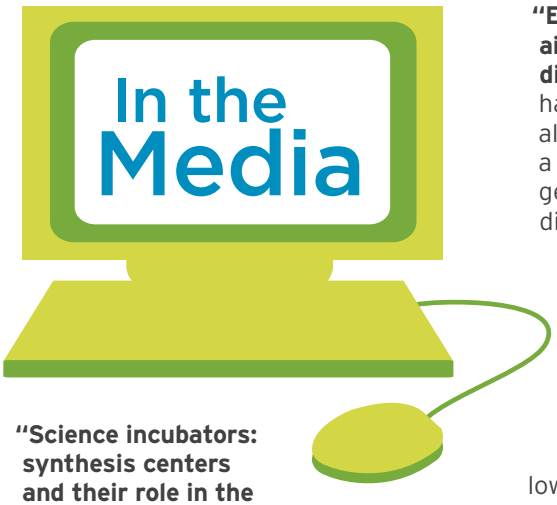
Jonathan Sullivan (University of Alabama, Huntsville)

Carrie Tribble (Williams College)

Madhvi Venkatraman (Occidental College)

Randee Young (Louisiana State University)

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



"Science incubators: synthesis centers and their role in the research ecosystem" (PLOS Biology) How to foster scientific information? NESCent Director Allen Rodrigo and colleagues argue that synthesis centers play a critical role as startup incubators for science. Learn more at **bit.ly/UOn8g1**

"Uncovering Africa's oldest known penguins" (NBC News) Africa isn't the kind of place you might expect to find penguins. But one species lives along Africa's southern coast today, and newly found fossils confirm that as many as four penguin species coexisted on the continent in the past. Exactly why African penguin diversity plummeted to the one species that lives there today is still a mystery, but changing sea levels may be to blame. The fossil findings represent the oldest evidence of these iconic tuxedo-clad seabirds in Africa, predating previously described fossils by 5 to 7 million years, says NESCent postdoc Dan Ksepka. Also picked up by Discovery, the Huffington Post, the UK Daily Mail and Scientific American. Read the full story at **bit.ly/14qKT7J**.

"The safer sex? For a little-known primate, a new understanding of why females outlive males" (Futurity) After observing an endangered lemur for more than two decades in the wild in Madagascar, researchers had a hunch that females were living longer than males. What could explain the gender gap? By taking a closer look at dispersal behavior across the lifespan, NESCent postdoc Jennifer Verdolin and colleagues think they have a clue. Find out more at **bit.ly/Z3AHL5**.

"Ethiopians and Tibetans thrive in thin air using similar physiology, but different genes" (Futurity) Scientists have pinpointed genetic changes that allow some Ethiopians to live more than a mile and a half above sea level without getting altitude sickness. The genes differ from those reported previously for high-altitude Tibetans, even though both groups cope with low-oxygen in similar physiological ways, the researchers say. The study adds to our understanding of how high-altitude populations worldwide have evolved to be different from their low-altitude ancestors. NESCent researcher Cynthia Beall of Case Western Reserve University and colleagues tell the full story at **bit.ly/THbrY2**.

"Text-mining spat heats up: scientists and publishers clash over licenses that would let machines read research papers" (Nature) It is seen as the future of computer-based research – if only the gatekeepers would let scientists in. Fearful that their content might be freely redistributed, publishers tend to block computer programs that they find crawling across the full text of research articles, a methodology known as text mining that can reveal large-scale patterns in the studies. NESCent postdoc Heather Piwowar says that it is unfair that large firms such as Google are allowed to crawl across content to index it – yet scientists are restricted: **bit.ly/147X2gq**.

"Study proposes alternative way to explain life's complexity" (Science Daily) Evolution skeptics argue that some biological structures, like the brain or the eye, are simply too complex for natural selection to explain. Biologists have proposed various ways that so-called 'irreducibly complex' structures could emerge incrementally over time, bit by bit. But a new study proposes an alternative route. NESCent researchers Wim Hordijk and Dan McShea explain at **bit.ly/16SDNqa**.

"Value all research products" (Nature) A new funding policy by the US National Science Foundation now asks PIs to list research "products" rather than "publications" in their grant applications. This means that data, software, and other nontraditional scholarly work will count too. The new policy represents a sea-change in how researchers are evaluated, says NESCent postdoctoral fellow Heather Piwowar: **bit.ly/VT6mwH**.

Call for proposals

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.

Proposals for short-term visits are two weeks to three months. Proposals for sabbaticals may be for up to a full year. The next deadline for short-term visitors and graduate fellowships is July 1. For sabbaticals, catalysis meetings and course proposals, the next deadline is July 10:

- Apply to be a short-term visitor at NESCent. Next deadlines July 1, Sept. 1: **bit.ly/3X1cKb.**
- Graduate students are invited to apply for one-semester research fellowships in NC. Next deadline July 1: **bit.ly/chaQcr**.
- Evolution researchers of all nationalities are welcome to apply for sabbatical fellowships at NESCent. Next deadline July 10: **bit.ly/4beg6U**.
- Apply for meeting funds to bring 30 scientists together to tackle the research question of your choice. Next deadline July 10: **bit.ly/gKdzrX**.

For more information, please visit **bit.ly/cfJUjx**.

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**.

PUBLICATIONS

Recent publications by NESCent authors

Allen, G. and P. Unmack (2012). "A new species of rainbowfish (Chilatherina: Melanotaeniidae), from the Sepik River system of Papua New Guinea." *Aqua, Journal of Ichthyology and Aquatic Biology* 14: 227-237.

Chen, C., et al. (2013). "Understanding the role of three-dimensional topology in determining the folding intermediates of group I introns." *Biophysical Journal* 104(6): 1326-1337.

Davis, A., et al. (2013). "Ontogenetic development of intestinal length and relationships to diet in an Australasian fish family (Terapontidae)." *BMC Evolutionary Biology* 13: 53.

Fetherman, E., et al. (2012). "Genetic basis of differences in myxospore count between whirling disease-resistant and -susceptible strains of rainbow trout." *Diseases of Aquatic Organisms* 102: 97-106.

Francis, C. and J. Barber (2013). "A framework for understanding noise impacts on wildlife: combining ethology, ecology and bioacoustics to address an urgent conservation priority." *Frontiers in Ecology and the Environment.*

Hiatt, A., et al. "Getting to evo-devo: concepts and challenges for students learning evolutionary developmental biology." *CBE-Life Science Education In press.*

Ksepka, D., et al. (2013). "Fossil evidence of wing shape in a stem relative of swifts and hummingbirds (Aves, Pan-Apodiformes)." *Proceedings of the Royal Society B.*

Lanfear, R., et al. (2013). "Taller plants have lower rates of molecular evolution: the rate of mitosis hypothesis." *Nature Communications.*

McFall-Ngai, M., et al. (2013). "Animals in a bacterial world, a new imperative for the life sciences." *PNAS.*

McShea, D. and W. Hordijk (2013). "Complexity by subtraction." *Evolutionary Biology.*

Moorad, J. and M. Wade (2013). "Selection gradients, the opportunity for selection, and the coefficient of determination." *American Naturalist* 181(3): 291-300.

Nascimento, F., et al. (2013). "The role of historical barriers in the diversification processes in open vegetation formations during the Miocene/Pliocene using an ancient rodent lineage as a model." *PLOS.*

Neel, M., et al. "Estimation of effective population size in continuously distributed populations: there goes the neighborhood." *Heredity* In press.

Piwowar, H. (2013). "Altmetrics: value all research products." *Nature* 493: 159.

Shrestha, M., et al. (2013). "Shades of red: bird-pollinated flowers target the specific colour discrimination abilities of avian vision." *New Phytologist* 198: 301-310.

Smith, N. "15 vetted fossil calibrations for divergence dating of Charadriiformes (Aves, Neognathae)." *Paleontologia Electronica-Fossil Calibration Series* In press.

Smith, N. (2013). "The fossil record and phylogeny of the auklets (Pan-Alcidae, Aethiini)." *Journal of Systematic Palaeontology.*

Smith, N. (2013). "A new species of auk (Charadriiformes, Pan-Alcidae) from the Miocene of Mexico." *Condor* 115: 77-83.

Smith, N. and G. Mayr (2013). "Earliest northeastern Atlantic Ocean basin record of an auk (Charadriiformes, Pan-Alcidae): fossil remains from the Miocene of Germany." *Journal of Ornithology.*

Soltis, D., et al. "Phylogenetic relationships and character evolution analysis of Saxifragales using a supermatrix approach." *American Journal of Botany* In press.

Stoltzfus, A., et al. (2012). "Sharing and re-use of phylogenetic trees (and associated data) to facilitate synthesis." *BMC Research Notes* 5: 574.

Tecot, S., et al. (2013). "Risky business: sex differences in mortality and dispersal in a polygynous, monomorphic lemur." *Behavioral Ecology.*

Thomas, D. and D. Ksepka (2013). "A history of shifting fortunes for African penguins." *Zool. J. Linn. Soc.*

Unmack, P., et al. (2013). "Phylogeny and biogeogeography of rainbowfishes (Teleostei: Melanotaeniidae)." *Molecular Phylogenetics and Evolution* 67: 15-27.

Unmack, P., et al. (2013). "The role of continental shelf width in determining freshwater phylogeographic patterns in southeastern Australian pygmy perches (Teleostei: Percichthyidae)." *Molecular Ecology* 22: 1683-1699.

Uy, J. and R. Safran (2013). "Variation in the temporal and spatial use of signals and its implications for multimodal communication." *Behavioral Ecology and Sociobiology.*

Verdolin, J. and J. Harper (2013). "Are shy individuals less behaviorally variable? Insights from a captive population of mouse lemurs." *Primates.*

Williams, C. (2013). "Forest tree pollen dispersal via the water cycle." *American Journal of Botany.*

PENGUINS, continued

reconstructions suggest that five million years ago — when at least four penguin species still called Africa home — sea level on the South African coast was as much as 90 meters higher than it is today, swamping low-lying areas and turning the region into a network of islands. More islands meant more beaches where penguins could breed while staying safe from mainland predators.

But sea levels in the region are lower today. Once-isolated islands have been reconnected to the continent by newly exposed land bridges, which may have wiped out beach nesting sites and provided access to predators.

Although humans didn't do previous penguins in Africa in, we'll play a key role in shaping the fate of the one species that remains, the researchers add.

Numbers of black-footed penguins have declined by 80% in the last 50 years, and in 2010 the species was classified as endangered. The drop is largely due to oil spills and overfishing of sardines and anchovies — the black-footed penguin's favorite food.

"There's only one species left today, and it's up to us to keep it safe," Thomas said. ●

CITATION: Thomas, D. and D. Ksepka (2013). "A history of shifting fortunes for African penguins." Zool. J. Linn. Soc.

THIN AIR, continued

travelers to high altitude compensate by making more hemoglobin, the oxygen-carrying component of human blood. But high hemoglobin comes with a cost. Over the long term, excessive hemoglobin can increase the risk of blood clots, stroke, and chronic mountain sickness, a disease characterized by thick and viscous blood.

"Altitude affects your thinking, your breathing, and your ability to sleep. But high-altitude natives don't have these problems," said Beall, who has studied high altitude adaptation in different populations in Ethiopia, Peru and Tibet for more than 20 years. "They don't wheeze like we do. Their thinking is fine. They sleep fine. They don't complain of headaches. They're able to live a healthy life, and they do it completely comfortably," she added.

How do they do it?

Research over the last four decades has revealed that people born and raised in mountainous regions cope with altitude in different ways. Native highlanders in Tibet and some in Ethiopia, for example, are able to maintain relatively low blood hemoglobin concentrations at high altitude compared to their counterparts in the Andes, a trait that makes them less susceptible to chronic mountain sickness.

Tibetans and some Ethiopians have both evolved a dampened response to low oxygen, explained study co-authors Anna Di Rienzo and Gorka Alkorta-Aranburu of the University of Chicago.

The researchers wanted to pinpoint the genetic changes that enable Ethiopians to thrive in thin air, and to see if the same genes play a role for Ethiopians as found in recent studies for Tibetans.

To find out, they analyzed the genomes of nearly 260 Ethiopian villagers belonging to two ethnic groups: the Oromo, who began settling at high altitude in the Bale Mountains of southeast Ethiopia about 500 years ago, and the Amhara, who have lived at high altitudes in the Semien Mountains of northwest Ethiopia for at least 5,000 years.

Research by Beall and colleagues in the early 2000s revealed that Oromo cope with thin air in much the same way that lowlanders visiting high altitude do — i.e., by making more hemoglobin. In contrast, Amhara highlanders — whose ancestors have inhabited mountainous regions for thousands of years longer than the Omoro — are able to maintain blood hemoglobin levels that are roughly 10% lower than Omoro living at the same altitude.

Yamdrok Tso lake in Tibet, altitude of 4488 m. People born and raised in mountanious regions cope with altitude in different ways. PHOTO BY LUCA GALUZZI

A team led by Beall, Di Rienzo and Alkorta-Aranburu analyzed both groups' DNA, which was extracted from blood and saliva samples donated by Amhara and Omoro villagers born and raised at high (3700-4000m) and low (1200-1560m) elevations. Using a statistical technique called a genome-wide association study, the researchers scanned the genomes of highland and lowland Ethiopians from both ethnic groups in search of variants associated with hemoglobin levels in the blood.

Same solution, different genes

When they scanned the villagers' DNA, the researchers found a genetic variant associated with low hemoglobin levels in the Amhara. This variant was located in a different region of the genome than those previously found to be associated with low hemoglobin in Tibetans. In other words, the physiological coping mechanisms shared by Amhara and Tibetans in response to life at high altitude — ie., dampened hemoglobin levels — are due to different underlying genes.

It is still unclear whether the first settlers of high altitude regions in Ethiopia and Tibet carried different genetic variants with them when they arrived, or whether different mutations occurred in these populations after they got there. But it's clear that each group followed a different evolutionary pathway.

"They have a similar physiologic solution, but that doesn't necessarily amount to a similar genetic solution," Di Rienzo said.

For the Omoro — who are relative newcomers to high altitudes — the researchers also found differences between highlanders and lowlanders in DNA methylation, a chemical process that causes changes in gene activity, but doesn't necessarily alter the genetic code. While the differences aren't linked to hemoglobin levels, the results suggest that such changes may play a role in the early stages of high altitude adaptation, the researchers say. ●

CITATION: Gorka Alkorta-Aranburu, C. M. B., David B. Witonsky, Amha Gebremedhin, Jonathan K. Pritchard, Anna Di Rienzo (2012). "The genetic architecture of adaptations to high altitude in Ethiopia." PLOS Genetics.