

Curiosity on Mars | Humans' Mixed Ancestry | Building Robojelly

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ScienceNews

MAGAZINE OF THE SOCIETY FOR THE PUBLIC ■ AUGUST 25, 2012

**Genetic Rarities
Surprisingly Common**

**Dolphin Sonar Uses
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**How Identical
Twins Differ**

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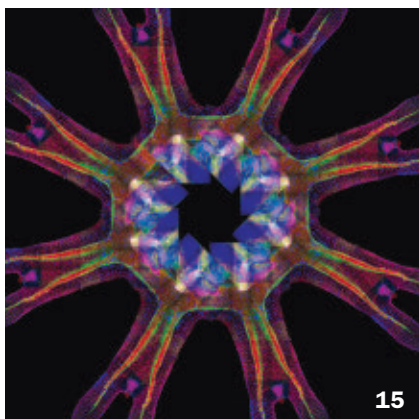


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COVER A meltwater stream cascades off Shivering Mountain in the Himalayas of northern India. The range's glaciers have responded inconsistently to warming climate.
Travel Ink/Getty Images

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FROM THE EDITOR

The scientific enterprise is a human-powered one



We just aren't that into people here at *Science News*. Only rarely do images of living humans grace the cover, or even the pages within. We tend to prefer fos- silized bones, green-glow cells, close-ups of beetles and simulations of subatomic phenomena. Or, at least that's my joke with the magazine's designers.

But in fact, *Science News* is very concerned with people: The magazine reports on the singularly human effort to explore the natural world, from distant planets to the distant past, from the origins of the cosmos to the origins of cancer cells. We never forget that science is shaped by people, even if we don't always show you their mugs.

Nadia Drake's report on NASA's Curiosity rover (Page 5) is a good example. On the scene at the Jet Propulsion Laboratory in Pasadena, Calif., she spent days interviewing scientists and engineers who had been planning the Mars rover landing for years. One scientist — picture and all — actually made it into this issue (Page 6). In a blog post, Drake also reported on a particularly human, superstitious ritual: As NASA scientists await a mission-critical moment, they share cans of peanuts. "I think missions have always seemed to work out better when we had the peanuts there," JPL's David Oh told Drake. Even the rover's main scientific goal seems enduringly human — to probe whether life could ever have called Mars home.

Some months ago we also launched a new column, People (Page 32), that tells quirky and personal stories of the research life and the people who live it. In this issue, for instance, you'll meet a researcher who studies endangered primates in the forests of China with help from a scat-sniffing dog.

A more notable change is in the people who bring you this magazine. Tom Siegfried, who so ably guided the *Science News* team since 2007, has stepped down, though he promises to continue to contribute. He is at work on a new book (rumored to be a more extensive take on the use and misuse of statistics in science). I have been named acting editor in chief, and Matt Crenson has taken on the duties of managing editor. Readers can rest assured that they will continue to find the same blow-by-blow accounts of science in progress, from the successful Curiosity landing to reconstructing the twisted path that led to the evolution of modern humans, as Bruce Bower details on Page 22. I hope you will join me in the continuing chronicles of the supremely human endeavor of science.

— *Eva Emerson, Acting Editor in Chief*

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Say What?

Lava balloon \LAH-vah buh-loon\ n.

A blob of steaming rock, erupted from an underwater volcano, that has a low enough density to float to the ocean surface. Scientists in the Portuguese islands of the Azores spotted lava balloons (shown) in an eruption that began in 1998 off the island of Terceira. Some of the balloons exploded after reaching the surface; all eventually sank. The balloons probably form as gas inflates lava puddled above the underwater volcanic vent, causing blobs to break off and rise, researchers report in the August *Bulletin of Volcanology*. —Alexandra Witze



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ON THE SCENE BLOG

The man at the rover lab's helm talks to *Science News*. See "A lifetime of curiosity: An interview with JPL director Charles Elachi."

LIFE

An unusually well-preserved fossil suggests dino ancestors were fluffy. Read "All dinosaurs may have had feathers."



HUMANS

DNA tracks Jewish migrations out of the Middle East. See "North African Diaspora written in genes."

SCIENCE & THE PUBLIC BLOG

Scientists debate a possible melanoma outbreak among coral trout in "Epidemic of skin lesions reported in reef fish."

Science Past | AUGUST 25, 1962

RUBY LASER PIERCES A SAPPHIRE CRYSTAL — A pulsed ruby laser piercing a sapphire crystal is shown on this week's front cover. The laser at the Radio Corporation of America Laboratories in Princeton, N.J., generates energy so intense that it can bore a sixteenth of an inch hole in the sapphire in a thousandth of a second. The heat produced at the surface of the crystal is at least 2,800 degrees centigrade.



Lasers are devices that amplify light waves and emit them "in step" to form a highly

directional and powerful beam of coherent light.... Their name is derived from the term, "light amplification through the stimulated emission of radiation." Able to amplify light waves just as radio waves are amplified, lasers already foreshadow an era in which light beams may be used in guiding space vehicles and communicating between planets.

Science Future

September 13

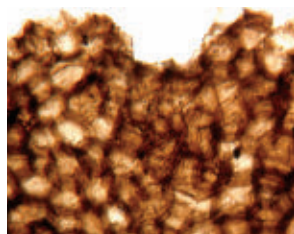
Take a swig of beer science at the Museum of Life + Science in Durham, N.C. Event will include samples of 10 local beers plus a chance to learn about beer chemistry and physics. See bit.ly/SFncbeer

September 15

Visit the Argonne National Laboratory outside Chicago for an inside look at the lab's energy research. Tour the lab, meet scientists and try hands-on demonstrations. Learn more at bit.ly/SFshowcase

The -est | OLDEST FUZZY ROCK

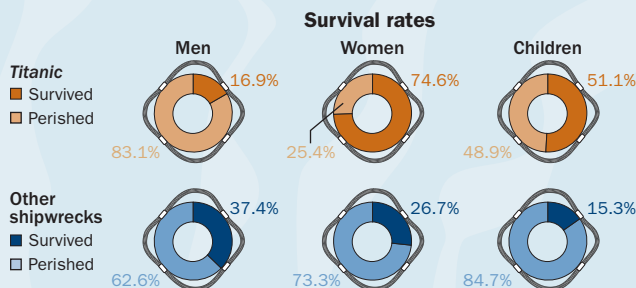
A rolling stone may gather no moss, but a sedimentary one sure can. Shale and other rocks collected near a German highway have yielded the oldest moss fossils ever discovered. Thin layers of well-preserved cells reveal three different species that lived in wetlands 330 million years ago, when many of the world's coal beds formed. The organisms resemble modern peat



mosses and lack the tiny pores and veinlike tissues present in vascular plants, Maren Hübers and Hans Kerp of the University of Münster report in the August *Geology*. —Devin Powell

Science Stats | CHIVALRY DIED LONG AGO

An analysis of 150 years of sinking ships finds that it's not always "women and children first." Male passengers were more likely to survive than women, and children fared even worse than women. The *Titanic* was an exception, compared with 16 other sinkings.



SOURCE: M. ELINDER AND O. ERIXSON/PNAS 2012

CLOCKWISE FROM TOP: CENTRE FOR VOLCANOLOGY AND GEOL. RISKS ASSESSMENT/AZORES; COURTESY HELMUT TISCHLINGER, EICHSTÄTT MUSEUM OF THE JURASSIC; MAREN HÜBERS AND HANS KERP/GEOL. 2012

“ We’re not just looking at people who were modern. We’re looking at people who were modern in a way that we know. ”

— FRANCESCO D’ERRICO, PAGE 16

Environment Heat wave thaws Greenland
Tropical reserves on the edge

Body & Brain Donor chains up transplants

Life Dolphin sonar trick deconstructed

Matter & Energy Add starch, walk on water

Genes & Cells Sequencing a single sperm

Humans A violent tradition written in bone

In the News

STORY ONE

Safe on Mars, rover begins the search for signs of habitability

Curiosity mission will probe
planet’s warmer, wetter past

By Nadia Drake

PASADENA, Calif. — Now, the real adventure begins.

After surviving a daring descent on August 5, NASA’s Curiosity rover is ready to embark on a mission of exploration that will take it up the flanks of a 5,500-meter peak and into terrain that formed when Mars was perhaps much wetter, warmer and more hospitable to life. If all remains well, the rover should have taken its first tentative scoots across the Martian dust by mid-September, leaving behind tire tracks studded with a Morse code message spelling out the initials of its birthplace, NASA’s Jet Propulsion Laboratory.

“There’s a lot ahead of us, but so far we are just ecstatic about the performance of the vehicle,” said Mars Science Laboratory mission manager Jennifer Trosper.

From the data and images the rover has sent back to Earth so far, it looks like Curiosity landed right where it needs to be. The rover set down in Gale Crater, a depression 154 kilometers across, near a peak called Mount Sharp that rises inside the depression. Scientists hope that Curiosity’s landing site is well-placed for a mission of 98 weeks — one



Even at a range of 6.5 kilometers, Mount Sharp looms large on the Curiosity rover’s Martian horizon. Soon the rover will climb the mountain’s flanks, reading an ancient environmental history recorded in layered geologic deposits.

Mars year — to find evidence for habitable conditions in the Red Planet’s past, or perhaps even its present.

Getting to Gale Crater was a technological tour de force culminating in an acrobatic “sky crane” maneuver that could have been ripped from a James Bond film. After more than eight months in space, the spacecraft carrying Curiosity entered the Martian atmosphere at nearly 21,000 kilometers per hour, deploying a parachute at 11 kilometers above the planet’s surface. At an altitude of 1.6 kilometers, while still falling at nearly 300 kilometers per hour, the parachute broke free, leaving Curiosity folded up like a giant bionic insect underneath the descent vehicle.

Then the descent vehicle fired its

retro-rockets, slowing the plunge even more and setting the stage for the sky crane maneuver to begin. At 20 meters above the planet’s surface — and now dropping at just 2.7 kilometers per hour — the rover descended from the mother ship on nylon cables, and the still-tethered pair moved slowly toward the surface.

After about 15 seconds, the rover touched down safely. It severed the nylon tethers, allowing the hovering descent vehicle to fly off and ditch itself in the dust about 650 meters away.

“Touchdown confirmed,” engineer Allen Chen reported at 10:32 p.m. PDT.

Like any considerate traveler, the rover’s first task after phoning home with news of its safe arrival was to



For full coverage of the Curiosity mission, visit www.sciencenews.org/msl

send pictures. The first one, received just minutes after touchdown, was a grainy black-and-white shot of the rover's rear wheel in front of a field of gravel, with Gale Crater's rim rising in the background. A later photo from the front of the rover shows Mount Sharp looming in the distance. The peak, an ancient pile of sediments rising higher above the surrounding terrain than any mountain in the Lower 48, holds rocky clues to understanding ancient Martian environments and past habitability. The evidence takes the form of geologic layers, some of which required water to form. As the rover climbs Mount Sharp, the clues Curiosity deciphers will help scientists understand how a planet that was once more like Earth became the dry, dusty and acidic ball it is today.

"Suddenly, the planet seems to have gotten dry," said project scientist John Grotzinger of Caltech.

The rover will analyze rocks with a variety of sophisticated instruments. One, the ChemCam, uses a laser to vaporize a small sample of rock or soil



Using an instrument called the ChemCam, Curiosity (illustrated) will vaporize samples of rock and soil with a laser. By analyzing the spectral properties of the emitted gas, the rover could identify traces of organic molecules associated with life.

from up to seven meters away. Then, onboard equipment can analyze the gas. Another instrument will drill into rocks, creating a powder that the rover can ingest and analyze for signs of things like organic carbon — a job that Grotzinger said is probably the most difficult the rover will encounter. "This

is a really hard thing to do, even on Earth," he said. "Even on a planet that's teeming with life, [organic carbon] almost never gets preserved."

Comparing Mars with Earth may help scientists understand how environmental triggers influence the evolution of life. When studying the origin and diversity of life on Earth, Grotzinger said, scientists often wonder what would have happened if specific events — such as the flooding of Earth's atmosphere with oxygen about 2.4 billion years ago — hadn't occurred. "Is there someplace that you can compare to where that didn't happen? That's Mars," he said.

Searching for signs of life from nearly 250 million kilometers away means scientists must write commands for their robotic proxy every Martian night and relay them to Mars for execution the following day, at least for the mission's first few months. Because Mars' days are roughly 40 minutes longer than Earth's, the scientists will have to work on an advancing schedule, slowly cycling from 9-to-5 to the graveyard shift and back.

"By working Mars time, it gives us basically 16 hours to plan an uplink while the rover is sleeping at night on Mars," said Curiosity mission manager Michael Watkins. ■

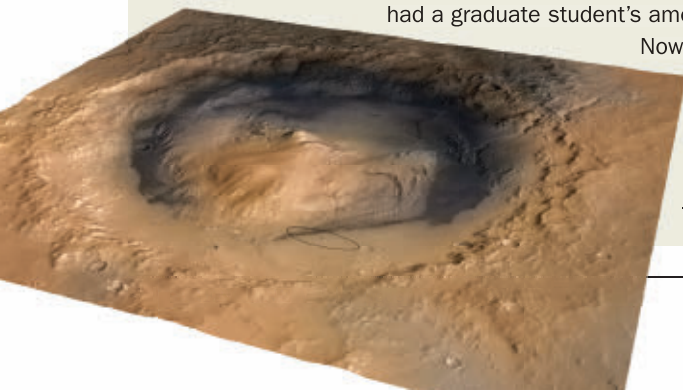
Back Story | TRIP ADVISOR



One of the biggest steps in sending a robotic rover to Mars is deciding where it's going to land. Choosing Curiosity's target on the Red Planet involved whittling down dozens of candidate sites, based on what scientists guessed the rover could learn within roaming distance of each one. In the end, NASA went with the recommendation of Ryan Anderson, a 27-year-old postdoctoral fellow at the U.S. Geological Survey in Flagstaff, Ariz., who started studying Gale Crater (below) in 2007 as a graduate student at Cornell University. By 2010, he'd published a massive paper with faculty member Jim Bell describing the crater's geologic features and proposing possible rover itineraries. That work, plus discussions of pros and cons at landing site workshops, helped put the crater on the landing-site shortlist. "There were a bunch of other people who were interested in Gale Crater," Anderson says. "But I was the only one who had a graduate student's amount of time to look at it."

Now Anderson is stepping into the role of team member on the mission as a collaborator on the rover's ChemCam instrument.

—Nadia Drake



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Environment



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Record melt year for Greenland ice as heat waves sweep across Arctic

Globe's second-largest ice sheet may face slushy future

By Alexandra Witze

Greenland's ice is on the hot seat again.

A heat wave, possibly the most extreme in a century, washed over the frozen island in mid-July, melting around 97 percent of the surface ice temporarily. Slush even appeared at Greenland's highest, coldest spot.

Overall, more of Greenland's ice melted in June and July than in any previous year during the satellite era, says Marco Tedesco of the City University of New York.

Weather and climate patterns conspired this year to produce what Ohio State University glaciologist Jason Box calls a "one-two-three-four-five punch." Among other things, a strong warming trend shifted much of the upper snowpack closer to the melting point. When a dome of particularly warm air began moving over Greenland on July 8, things were primed for nearly all of the snow on top to thaw.

At the Summit Camp research station, more than 3,200 meters above sea level, the thermometer soared above freezing

for several days straight. It was the first significant melt at the site since 1889, says Mary Albert, an ice expert at Dartmouth College.

At a second site 700 kilometers to the northwest, "it was wet and slushy, which made it really hard to walk around on the ice without falling knee-deep into the snow," says Dartmouth graduate student Kaitlin Keegan. Flags planted in the snow began to topple. Supply planes were unable to land on the once-solid runways.

Ice cores from that site show evidence of similar melt in 1946 (though to a lesser degree) and in 1889, says Dorte Dahl-Jensen of the University of Copenhagen. "So it is rare indeed," she says.

Temperatures soared again during the last week of July, as a second warm air mass moved over the island. The air was warm and foggy, and the ice-block-throwing competition scheduled as part of the "Icelympics," polar scientists' companion to the London Games, had to be canceled because the blocks were melting.

"Nature could have caused this [year's] melt event by chance," says Richard Alley, a glaciologist at Penn

State University. "But humans made it more likely with greenhouse gases."

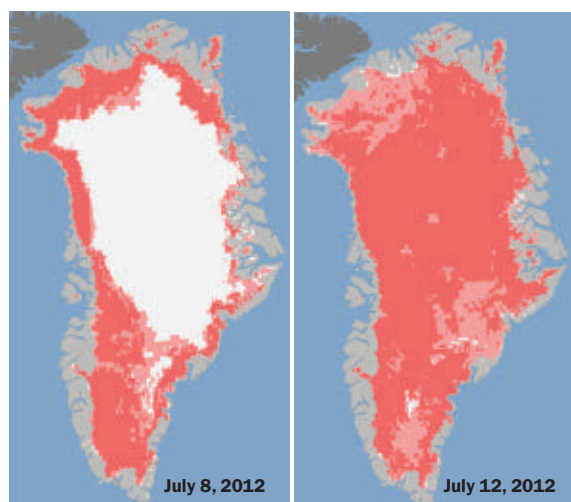
By measuring microwave energy coming off Greenland, satellites can see how much meltwater there is versus how much ice. During the peak of the July melt, Summit's uppermost snow contained about one-tenth as much melt as that seen in areas closer to the southwest coast, where melting has been most pronounced in recent years, Tedesco and his colleague Xavier Fettweis of the University of Liège in Belgium found.

Overall, Greenland has been losing close to 300 billion metric tons of ice yearly. At Summit Camp, meltwater refreezes in place, but at lower elevations it runs off into the oceans and contributes to sea level rise.

The two regions most sensitive to rising surface temperatures are southwestern and northwestern Greenland, Tedesco says. "Those are the two exposed nerves," he says. In the Southwest, raging meltwaters washed out a bridge in the town of Kangerlussuaq on July 11. In the Northwest, the Petermann Glacier broke off a massive chunk of ice on July 16, the second huge iceberg calving in two years.

But not all such headline-making events can be linked to surface warming, Kurt Kjaer of the University of Copenhagen and his colleagues write in the Aug. 3 *Science*.

Kjaer's team used old aerial photographs to study how surface elevation had changed in northwestern Greenland since the mid-1980s. Looking closely at glaciers along the northwest coast, the scientists found two periods in which more ice than usual flowed into the ocean. Roughly 26 billion metric tons were lost annually in short-lived speedups from 1985 to 1993, and again from 2005 to 2010, the researchers report. Neither of these two speedups were predictable, they say. "This finding challenges predictions about the future response of the Greenland ice sheet to increasing global temperatures," they write.



Big thaw The surface of the ice sheet that covers Greenland, an island three times the size of Texas, melted almost entirely in mid-July when a dome of warm air parked itself over the land mass. The first image shows satellite data from just before the heat wave. The second image shows the condition of the ice sheet a few days later, when an estimated 97 percent of the surface had thawed.

- No data
- Ice/snow free
- Probable melt
- Melt
- No melting

"I was surprised that so much ozone could be removed in such a short time." —DALE HURST

Stronger storms may eat ozone

Extra water vapor aloft could trigger destructive reactions

By Devin Powell

Climate change may spur the destruction of ozone in unexpected places.

In a warming world, many scientists believe, severe weather will become more common. That could be a problem in part because powerful rainstorms high above the United States have the potential to erode ozone, which blocks damaging ultraviolet rays, researchers report online July 27 in *Science*.

"For 30 years, we've studied the problems of ozone loss and climate change separately," says team leader James Anderson, a Harvard atmospheric scientist. "Now it's pretty clear that climate change appears to be linked directly to the loss of ozone."

Anderson and his colleagues stumbled on the unexpected connection while studying strong summer storms fueled by rising heat. During missions from 2001 to 2007, NASA planes flying close to the

edge of space spotted water spewed high into the sky by convective storms over the United States. The goal was to gather useful measurements for figuring out how high-altitude clouds form and trap heat.

But the data also revealed a possible threat to ozone molecules floating 15 to 20 kilometers up. Large storms often left behind extra water vapor in this part of the stratosphere, the remnants of melted ice crystals propelled upward.

That vapor could set the stage for a chemical chain reaction that produces chlorine compounds, including pairs of chlorine atoms. Sunlight cleaves those molecules, spitting out unstable chlorine atoms that break down ozone.

"It's the same chemistry as that going on above the Arctic and the Antarctic," says Anderson. Chlorine from human-made chemicals has chewed seasonal holes in ozone above Antarctica and caused thinning above the Arctic.

The team's calculations suggest that

the havoc wreaked by water vapor could continue for days after a storm, as humidity levels slowly fall. As much as 25 to 35 percent of ozone, over a horizontal distance of 100 kilometers, could be annihilated in a week.



NASA aircraft studying storms over the United States have found evidence that global warming may increase the lofting of water vapor into the stratosphere.

"I was surprised that so much ozone could be removed in such a short time," says Dale Hurst, an atmospheric chemist at the University of Colorado Boulder's Cooperative Institute for Research in Environmental Sciences.

For now, the danger is only on paper. Actual measurements tracking chlorine compounds in the stratosphere would help to confirm whether

the damage is taking place and, if so, how widespread the problem may be.

"It's a bold idea that raises more questions than it answers," says Andrew Dessler, a climate scientist at Texas A&M University in College Station. "But this is what great scientists do: They come up with ideas that spur people to start working on new things." 

Outside ills imperil tropical reserves

Impacts beyond park boundaries pressure ecosystems

By Alexandra Witze

One of the first broad looks at how well tropical reserves protect biodiversity has found that many are in decline due to conditions just beyond their borders.

Logging, deforestation and fires just

outside a park had strong effects on a reserve's health, whereas factors such as air and water pollution were less important, new research finds.

William Laurance, an ecologist at James Cook University in Cairns, Australia, and more than 200 coauthors report

the findings online July 25 in *Nature*.

"It's the first crack at an extremely important problem," says Lucas Joppa, a conservation biologist at Microsoft Research Cambridge in England.

The researchers interviewed field biologists working in 60 reserves across 36 nations. In detailed questionnaires and interviews, the local experts reported trends in 31 animal and plant groups. The researchers also asked about 21 potential drivers of ecosystem change such as illegal mining, hunting and selective logging.

After cross-checking the experts' knowledge with published scientific literature, Laurance's group came up with a "reserve-health index." About four-fifths of the reserves had a declining index. 



This red-eyed tree frog (*Agalychnis callidryas*) lives on Panama's Barro Colorado Island, one of many areas where biodiversity is protected by a reserve.

Body & Brain

Donor chains help neediest

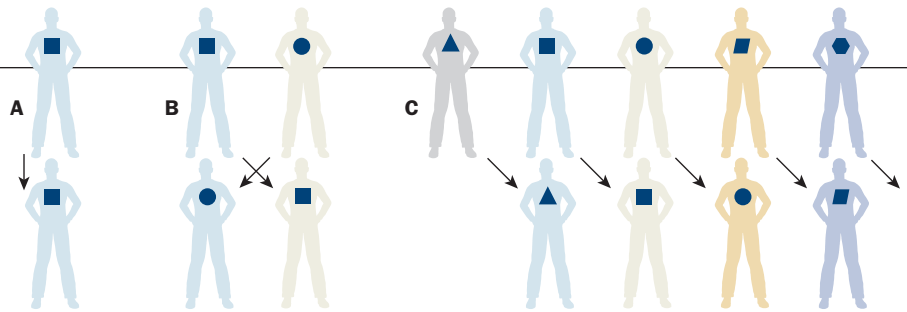
Big networks deliver more organs to the hard-to-match

By Rachel Ehrenberg

When a person donates a kidney to a broad pool of potential recipients, that single altruistic act can kick off a long chain of donations that leads to more transplants for hard-to-match patients, a mathematical analysis concludes.

Many people needing kidney transplants have a willing donor, but they can't take the organ because it's not compatible with their blood type or immune system. Paired exchanges, where incompatible donor/recipient pairs swap kidneys with another incompatible pair, are one trick for getting kidneys into hard-to-match patients. Another trick is a donor chain: A person gives a kidney to a clearinghouse or kidney exchange, which can set off a chain of donations.

There has been debate over whether long chains ultimately mean more transplants. "The mathematical question was: 'Are we really transplanting more



Transplant trade When a kidney donor and recipient are compatible (A), a transplant can proceed. If donor and recipient aren't compatible, paired donation (B) can match two incompatible donor-recipient pairs. A kidney donation chain (C) kicked off by an altruistic donor can result in even more transplants, especially for hard-to-match patients, a new mathematical analysis concludes. Last year, a nationwide chain of 30 transplants was organized among 17 hospitals in the United States.

people?" says Alvin Roth, an expert in game theory and market design at Harvard. "The answer is yes, a lot more."

Long chains can result in 30 percent more transplants than a cycle of three exchanges, Roth and his colleagues calculated. These chains especially benefit patients who are hard to match, the researchers report in a National Bureau of Economic Research working paper released in July.

Prospective transplant recipients can be hard to match when they are what doctors call highly sensitized: These patients build up antibodies that attack most foreign tissue. Roth and his colleagues collected data on the number of highly sensitized patients

typically found in a kidney exchange pool. Because easy-to-match pairs often don't enter pools, hard-to-match, sensitized patients can accumulate.

The researchers then developed an algorithm that finds the greatest number of matches for a pool of a given size with a given number of sensitized patients.

A considerable gap can exist between mathematical simulations and the real world, says Dorry Segev of Johns Hopkins, who believes shorter chains are better. There's always the danger that potential donors will change their minds or end up unable to give up a kidney for medical reasons. "The longer the chains are," Segev says, "the higher chance they will fall apart."

Night lights may foster depression

Hamster study also finds that the symptoms are reversible

By Janet Raloff

Chronic exposure to light at night unleashes depression, at least in animals.

In the new study, appearing online July 24 in *Molecular Psychiatry*, Tracy Bedrosian, Zachary Weil and Randy Nelson of Ohio State University exposed 13 Siberian hamsters to normal light and dark cycles for four weeks. For the next four weeks, six of the animals remained on this schedule, and seven received chronic dim light throughout their night.

Compared with animals exposed to normal nighttime darkness, those getting dim light at night lost their intense preference for sweet drinks, "a sign they no longer get pleasure out of activities they once enjoyed," Bedrosian says.

In a second test, animals were clocked on how long they tried to escape a pool of water. Hamsters exposed to night light stopped struggling and just floated in the water 10 times as long as animals that had experienced normal nighttime darkness.

Examination of tissue from the hippocampus — a brain structure that plays

a role in depression — showed that animals that got light at night sported fewer nerve cell protrusions known as dendritic spines. These structures mark sites of communication between cells. Such spine reductions "are consistent with what we see in humans with major depression," Bedrosian says.

All symptoms of depression, including the nerve cell changes, disappeared within two weeks of the animals' return to a normal light-dark cycle.

Human studies linking nighttime light and mood disorders are important but can't easily probe molecular underpinnings the way animal studies can, says George Brainard of the Jefferson Medical College in Philadelphia.

15.4
percentHIV prevalence among
men in Orange Farm,
South Africa, 2008**12.3**
percentHIV prevalence among
men in Orange Farm,
South Africa, 2011

Male circumcision lowers HIV rate

Community programs changing public opinion of procedure

By Nathan Seppa

An increase in male circumcision in a South African community coincides with lower overall HIV rates among adult men, a new study finds. Meanwhile, a report from Kenya bolsters earlier findings that circumcised young men are less than half as likely as their uncircumcised peers to acquire HIV. Both reports were presented July 24.

Researchers in Orange Farm, South Africa, devised a program in 2008 that provided free circumcision for men, plus condoms and counseling. Within three years, the adult male circumcision rate jumped from 17 percent to 54 percent, said Bertran Auvert, a physician at the University of Versailles in France who works on the project.

Surveys of several thousand men in Orange Farm in 2008 and 2011 found

that the prevalence of HIV dropped from 15.4 to 12.3 percent during that time. Auvert calculated that there were 1,040 HIV infections avoided.

The decrease in HIV prevalence, he said, should lead to a decrease in HIV rates for the men's female partners. "It's the beginning of the story, so we'll need some time," he said.

An earlier trial in Orange Farm was among the first to show that male circumcision can reduce HIV infection risk. A new analysis of data from a similar trial in Kisumu, Kenya, suggests the protection is long-lasting. Epidemiologist Robert Bailey of the University of Illinois at Chicago reported that 66 months after circumcision, men who underwent the operation were still less than half as likely to become infected with HIV as men who didn't undergo it.

"After five and a half years of follow-

up, the fact that these results are consistent over time suggests the protective effect is sustained," Bailey said.

Researchers had noticed a link between circumcision and reduced HIV risk when maps of Africa showed higher HIV rates in regions, notably eastern and southern Africa, where male circumcision isn't performed as a traditional practice. Before the first circumcision trials in Africa were started about a decade ago and results from those tests were made public, many people in Africa "thought that circumcision equated to becoming a Muslim," said Samson Kironde, a physician in Jinja, Uganda, at the JSI Research & Training Institute and with the U.S. Agency for International Development. The community-wide effect seen at Orange Farm "is significant," he says, "and that's the aim."

Kironde says that by some estimates, circumcising 80 percent of men in a community "would allow you to reach a critical mass of people" that would have a potent community-wide effect. 

MEETING NOTES

Elite controllers might thwart key viral protein

A fortunate 1 percent of people infected with HIV don't develop AIDS symptoms. These people are termed "elite controllers" for their ability to keep the virus in check. New research finds that a key viral protein that plays several roles in HIV infection, called Nef, is largely dysfunctional in elite controllers. Viral immunologist Philip Mwimanzu of Simon Fraser University in Vancouver and his colleagues compared HIV from 45 elite controllers with 48 other patients whose disease was progressing typically. He and his colleagues found that Nef in elite controllers' HIV was substantially less able to invade cells or replicate than Nef in other patients. In elite controllers, Nef also failed to sabotage

first-alert immune proteins belonging to the HLA class, a defect that would help the immune system control the virus. — *Nathan Seppa*

Heartburn drugs tied to fractures in HIV patients

Proton pump inhibitors, marketed for acid reflux under names like Prilosec and Nexium, might increase the risk of bone breaks in HIV patients, a study in more than 40,000 middle-aged male veterans shows. The 588 people who broke a bone over an average of six years were nearly twice as likely to be on a PPI as were those with no bone breaks, said Julie Womack, a nurse-researcher at Yale University who presented the data July 23. PPIs' acid-blocking effect may encourage fractures by thwarting bone remodeling processes. — *Nathan Seppa*

Safer sex through soap operas

A weekly dose of educational soap operas could help keep women HIV-free, HIV prevention researcher Rachel Jones of Rutgers University in Newark, N.J., reported July 25. Jones' team produced a 12-part dramatic video series that promoted safer sexual decisions. Women who watched the series had 19 percent fewer risky sexual encounters—unprotected sex with men they identified as promiscuous or drug users—than those who received text messages about preventing HIV, Jones and a colleague report in the July *AIDS and Behavior*. The soap opera followed four heroines navigating relationship dilemmas with men—like a more responsible version of *Sex and the City*. "The women loved the videos," said Jones. "They watched most two or three times." — *Meghan Rosen*

Life



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Moss odor draws sperm carriers

Springtails boost primitive plants' reproductive success

By Susan Milius

Mosses may get a reproductive boost by luring tiny animals to deliver plant sperm.

Male moss plants don't make pollen, but instead send sperm swimming through dew in search of a female moss. Earlier research in dry lab containers showed that moss sperm can hitchhike on mites and little arthropods called spring-

tails. "The question was, 'But do they?'" says evolutionary ecologist Sarah Eppley of Portland State University in Oregon.

Now, lab tests with two moss species have shown that in dewy conditions, springtails increased moss fertilization. With water alone, sperm found female moss in roughly a third of moss test clumps, but water plus springtails raised the number to almost half, Eppley and colleagues report online July 18 in *Nature*.

The new paper improves the case for springtail sperm delivery, says evolutionary bryologist Nils Cronberg of Lund University in Sweden. His earlier work had suggested that fertile mosses attract little animals; the new tests show that fertile moss shoots emit many scent



Tiny springtails (center) preferred the scent of female mosses over males in a new study.

compounds, suggesting that scent guides springtails to those fertile shoots.

It's not yet clear what the springtails might be getting out of this arrangement. Eppley notes that reproductive mosses can ooze sugary droplets, which little animals might fancy. 🍯

Test decodes dolphins' sonar skill

Nonlinear math may explain ability to 'see' through bubbles

By Meghan Rosen

Dolphins could teach humans a thing or two about finding Nemo. The aquatic mammals may use mental math to pinpoint prey hidden in bubbles.

By adjusting the volume of sonar clicks, then processing the echoes, dolphins might have solved a problem that still stymies human-made sonar: how to peer through frothy water. Using clicks that mimic an Atlantic bottlenose dolphin, scientists devised a system that weeds out sound clutter from underwater bubbles.

"It's really ingenious, actually," says oceanographer Grant Deane of the Scripps Institution of Oceanography in La Jolla, Calif. "I think it's very clever work, and there are a number of significant applications for it."

Using something like a firefighter's hose, researchers shot bubbles into a huge underground water tank. The bubbles cloaked a submerged steel ball slightly smaller than a baseball. Then the researchers sent out short bursts of sound, collected the echoes, and processed the data mathematically

to figure out the steel ball's location.

It worked "brilliantly," says physicist and engineer Timothy Leighton, who led the study, published online July 18 in the *Proceedings of the Royal Society A*.

The findings could allow sonar for mine-hunting submarines to see more clearly in murky shallow waters.

Normally, using sonar to locate targets in bubbly water is a bit like driving a car at night in thick fog, says Leighton, of the University of Southampton in England. Headlights don't help; fog droplets just scatter the light. Similarly, bubbles scatter sound. But the bubbles kick back sonar signals perhaps a million times as powerfully as equally sized steel balls in water do, Leighton says. This peppy bounce back makes it even trickier for sonar to look through foamy waters.

And yet scientists have observed dolphins blowing bubble nets — dense clouds of tiny bubbles — while hunting fish.

The researchers used nonlinear mathematics to process the simulated dolphin sonar returns.

"I don't think dolphins are sitting there playing with numbers in their heads," Leighton says, but their brains might be using mathematics to decipher bubble-scattered sonar signals. 🧠



By studying the clicks of Atlantic bottlenose dolphins, researchers have figured out a way to create sonar that sees through bubbles.

Matter & Energy

“If you were to punch the suspension, you might break your wrist.” —SCOTT WAITUKAITIS

Walking on water mystery solved

Friction helps surface of cornstarch solution push back

By Devin Powell

Dump enough cornstarch into a swimming pool, and you can trot across the water's surface. Scientists now know the secret of this YouTube party trick.

When struck by a foot, the particles suspended in the water jam together like snow piling up in front of a snowplow. The compaction forms a hard patch that can push back with the same amount of bone-crushing pressure concentrated at the tip of a high heel, researchers report in the July 12 *Nature*.

“If you were to punch the suspension, you might break your wrist,” says Scott Waitukaitis, a physicist at the University of Chicago who was inspired to study the goop by videos of people running on it.

Water added to equal or larger quantities of cornstarch has long been a staple of science fair demos, thanks to the mixture's Jekyll-and-Hyde personality. A non-Newtonian fluid, it doesn't behave like most liquids. A hand can slide in gently, without much resistance. But smack the surface hard, and it smacks back.

To understand the forces at work, the researchers struck the mix soundly with a metal rod and monitored the repercussions. In previous experiments, researchers had rubbed the material between two plates — a common technique for testing the properties of liquids, but one that shears the fluid sideways instead of producing a direct impact.

X-rays of the opaque muck revealed how the stuff moved beneath the surface.

Simulations based on the data suggest that the initial impact squeezed water out of the spaces between the particles. Friction between the particles then took over. They stuck together in an expanding front that behaved like a solid, pushing back against the rod.

“I was not extremely surprised by the results,” says Daniel Bonn, a physicist at the University of Amsterdam who suspected a similar mechanism after shooting bullets into cornstarch suspensions. “But the experiment was interesting because they're able to look inside the cornstarch as it thickens.”

Both Bonn and Waitukaitis hope that understanding how cornstarch solutions behave will help other researchers who try to make “liquid” body armor by soaking Kevlar in similar suspensions. But the scientists both caution that what happens in one suspension may not happen in another. 📺

The advertisement displays eight car parts arranged in two rows. Each part is labeled with either a green checkmark and the word 'Yes' or a red 'X' and the word 'No'. The parts are: a timing belt (Yes), a spark plug (Yes), a yellow cartoon fish (No), a metal air filter (Yes), a side mirror (Yes), a blue engine block (Yes), a pair of wiper blades (Yes), and a brake pad (Yes).

Below the parts, on a dark blue background, is the RockAuto.com logo, which features a stylized 'RA' in a blue and white wave-like shape. Below the logo, the text reads: "ROCKAUTO.COM", "ALL THE PARTS YOUR CAR WILL EVER NEED", and "GO TO WWW.ROCKAUTO.COM ROCKAUTO, LLC (EST. 1999)". To the left of the logo, four bullet points list the company's benefits: "✓ Everyday Low Prices", "✓ Easy To Use Website", "✓ Huge Selection", and "✓ Fast Shipping".

Genes & Cells



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Identical twins differ in womb

DNA modifications at birth may influence adult health

By Tina Hesman Saey

Twins emerge from the womb carrying differing chemical marks on their DNA that influence the activity of individual genes, a new study shows.

Known as epigenetic markers, these alterations don't change the underlying genetic information. But by regulating the activity of certain genes, they can influence how the DNA blueprint is used to create and operate a living organism.

Scientists knew that epigenetic markers differ in identical twins. But those differences were thought to arise after birth, as twins have different experiences

and encounter different environments.

The new study — the first to measure epigenetic profiles in newborns — suggests that subtle differences in the womb can leave marks on DNA that may have long-term consequences for adult health.

These differing chemical tags may help explain why identical twins look slightly different, have their own personalities and may have different susceptibility to diseases. Jeffrey Craig, a molecular and cell biologist at Murdoch Childrens Research Institute in Parkville, Australia, and his colleagues report the findings in the August *Genome Research*.

Identical twins are on average more epigenetically similar than fraternal twins, the researchers found. That may not be because identical twins have the same genes, suggests Arturas Petronis, an epigenetics researcher at the University of Toronto; it could be because they inherit the same epigenetic signature.

Just as eggs and sperm carry different combinations of parental genes, the cells are also marked with different epigenetic tags. So identical twins, which result when a single embryo splits, start out with the same epigenetic profile. Fraternal twins, the product of separate fertilization events, begin with slightly different epigenetic patterns, Petronis says.

Craig and colleagues found that birth weight was associated with differing epigenetic tags on genes involved in metabolism, growth and cardiovascular disease. Low birth weight has been linked to obesity and heart disease in adults.

Factors in the womb influencing fetus growth, such as size of the umbilical cord, may also create epigenetic discrepancies between twins. Identical twins sharing a placenta were more epigenetically different than twins who had their own; perhaps one got slightly more nutrition from the single source, Craig says. 

Sperm's genetic blueprint compiled

Analysis uses sex cells to calculate human mutation rates

By Tina Hesman Saey

Some scientists really throw themselves into their research, but Stanford biologist Stephen Quake has taken the all-in approach to a whole new level.

Using his sperm, Quake and colleagues compiled the first-ever genetic blueprint for a single sperm cell. The results shed light on molecular processes such as mutation and recombination in humans, the scientists report in the July 20 *Cell*.

Determining how often mistakes in copying DNA results in mutations to single DNA units is important for various reasons, including figuring out how long ago humans diverged from other species, says Laure Ségurel, an evolutionary geneticist at the University of Chicago. "Every calculation is based on this mutation rate," she says.

In past studies, scientists estimated

this rate either by comparing human DNA with that of other species to see how many changes occurred since that species split from humans, or by studying families to see where children have different DNA than their parents. For individual sperm cells, Quake and colleagues calculate the human mutation rate at 2 to 4 changes per 100 million DNA units per generation. That is higher than the rate calculated by looking at families, but consistent with evolutionary estimates.

The new work also offers insights into how humans scramble their DNA so that children inherit different combinations of parental DNA. This process, called recombination, is thought to be directed by a protein called PRDM9, which latches on to DNA and governs where the breaks that allow gene swapping will happen.

But the Stanford researchers found that PRDM9 isn't always necessary for

recombination. Many of the new recombination hot spots fall within transposons — mobile pieces of DNA often called "jumping genes" — that don't have obvious places for PRDM9 to grab.

Just because PRDM9 doesn't seem to grasp DNA directly everywhere recombination happens doesn't mean the protein isn't involved in every gene swap, says Ségurel.

Regardless of PRDM9's involvement, the data suggest that transposons may have had an important hand in shaping human evolution. "This is a nice mark in the transposon column," Quake says.

Sperm are challenging for genetic analysis because they contain so little DNA, says Stanford biological engineer Jianbin Wang, a study coauthor. Sperm and eggs each contain half as much genetic material as a typical body cell. But sperm have an advantage when scientists analyze the small portion of the genome that contains protein-coding genes. With only one copy of each gene per sperm, researchers don't mix up two copies with each other. 

Polar bears have ancient origins

White version split from brown cousins millions of years ago

By Devin Powell

The polar bear has been around for a surprisingly long time. A new DNA analysis suggests that *Ursus maritimus* split from the brown bear between 4 million and 5 million years ago—around the time when, some scientists believe, the Arctic's thick sea ice first formed.

With such old origins, the bears must have weathered extreme shifts in climate, researchers report online July 23 in the *Proceedings of the National Academy of Sciences*. Simulations of how the DNA changed over time suggest that polar bear populations rose and fell with the temperature. After thriving during cooler times between 800,000 and 600,000 years ago, the bears seem to have suffered a genetic bottleneck and crashed after a warmer period that started about 420,000 years ago.

Whether the Arctic icon will survive today's warming is unknown. "Even if



Polar bears split from brown bears 4 million to 5 million years ago, a new study finds, indicating that the species weathered extreme shifts in climate.

this species has for sure experienced dramatic climatic changes before, that does not mean it's safe today," says evolutionary biologist Charlotte Lindqvist of the University at Buffalo in New York.

Lindqvist and colleagues had previously dated the polar bear's emergence to no more than 150,000 years ago, based on a fossil containing mitochondrial DNA, inherited from the mother. In April, the origin was pushed back to 600,000 years ago by Frank Hailer, an evolutionary biologist at the Biodiversity and Climate

Research Centre in Frankfurt. His team examined over 9,000 letters in nuclear DNA of modern bears. The new study provides an even clearer picture, says Lindqvist, because it looks at the entire genetic blueprints of 23 modern polar bears. Lindqvist and colleagues used more than 2.5 billion letters in the creatures' nuclear DNA and identified more than 13 million points of comparison.

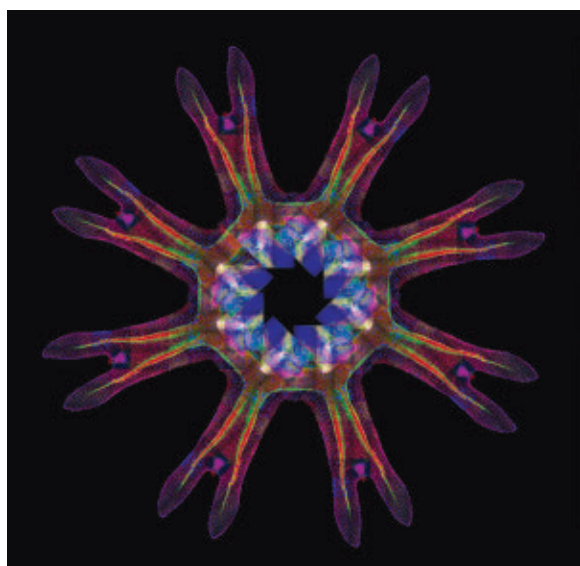
But that study was calibrated using the rate at which mutations appear in the DNA of primates, Hailer says. "They're assuming that the genetic clock in bears ticks at the same pace as that in primates."

The new research blurs the lines between the polar bear and its darker cousins. Isolated brown bears living in Alaska's Admiralty, Baranof and Chichagof islands trace between 5 and 10 percent of their DNA to polar bears, Lindqvist's team found. A previous study found that ancient brown bears in Ireland also shared much mitochondrial DNA with their comrades to the north.

So although polar bears and brown bears separated long ago, they seem to get together every so often for a fling—perhaps when the weather warms, sending polar bears southward and brown bears northward. ■

Fake jellyfish swims for real

Call it the Frankenjelly. Scientists have created an artificial jellyfish that swims with the same synchronized body contractions used by real jellyfish. After analyzing the swimming dynamics and layout of tissues in the common moon jelly *Aurelia aurita* (false-color composite of a juvenile shown), the scientists fashioned an umbrella-shaped frame with eight armlike structures out of an elastic silicone polymer, then seeded the frame with rat heart cells. Guided by minuscule patterning on the polymer, the rat cells grew into a layer of muscle. When let loose in a tank, the fake jellyfish's muscles spontaneously began contracting. Applying an electric field spurred it into swimming that matched the kinetics of live jellyfish. A key to the approach was focusing on propulsion—the function of jelly muscles—not on form alone. The work could lead to other tricks for engineering body parts, such as muscular pumps or other organs, or even whole body mimics of other creatures, the Caltech and Harvard researchers conclude online July 22 in *Nature Biotechnology*. —Rachel Ehrenberg



FROM TOP: URYADNIKOV SERGEY/SHUTTERSTOCK; JANNA NAWROTH/CALTECH

Humans

Mideast violence goes way back

Head wounds common in region for last 6,000 years

By Bruce Bower

Head-bashing hostilities haunted the Middle East long before the region's current conflicts arose. Skulls of people who occupied the lands of Israel and the West Bank over the last 6,000 years display a consistently high rate of serious injuries.

These head wounds typically were inflicted in small-scale brawls, not wars, say anthropologist Israel HersHKovitz of Tel Aviv University and his colleagues.

Skull injuries vary in frequency from about 1 percent to 25 percent at ancient sites around the world. Among human skulls previously excavated in Israel and the West Bank, 25 percent of individuals had suffered severe head wounds,



A study of 783 skulls excavated in Israel and the West Bank found that 25 percent showed evidence of head wounds, including blunt force trauma (left) and knife or sword wounds (right).

whether they lived during the Copper Age or as recently as a century ago, the researchers report online July 11 in the *International Journal of Osteoarchaeology*. That rate held for skulls from farming and urban populations and from societies that included Egyptians, Babylonians and Assyrians.

HersHKovitz's team, which includes Palestinian anthropologist Issa. Jubrael. Sarie of Al-Quds University in Jerusalem, examined 783 skulls from old community cemeteries, excluding massacre sites and battle graves.

Some head injuries in the new study might have resulted from warfare.

Instances of such damage would have been even greater had the researchers examined skulls from battle sites, comments archaeologist Augusta McMahon of the University of Cambridge in England. "Prehistory was not peaceful," says McMahon, who is directing excavations of a 5,800-year-old mass grave in Syria.

For ancient populations that were armed mainly with clubs, injuries caused by one-on-one fights or warfare are difficult to distinguish. "A mace blow received from a neighbor during an argument and a mace blow received from a foreign enemy in battle look the same on a skull," McMahon says. 📌

Cave yields African culture's roots

Artifacts much like those used by today's hunter-gatherers

By Meghan Rosen

People living in a South African cave 44,000 years ago crafted the same kinds of blades, beads and tools as hunter-gatherers of the region today. A new analysis of ancient artifacts pushes the history of modern human behavior in southern Africa back more than 20,000 years.

"We're not just looking at people who were modern. We're looking at people who were modern in a way that we know," says Francesco d'Errico of the University of Bordeaux in Talence,

France. He and his colleagues report the new work online July 30 in the *Proceedings of the National Academy of Sciences*.

Using radiocarbon dating, researchers pinpointed the ages of wooden digging sticks, ostrich eggshell beads, bone awls and stone flakes that may have been part of a sophisticated hunter-gatherer toolkit-cum-jewelry box.

The collection is characteristic of the Later Stone Age, a period many archaeologists believed began in southern Africa about 20,000 years ago. But the new radiocarbon dates show the Later

Stone Age actually emerged between 44,000 and 42,000 years ago, says study coauthor Paola Villa of the University of Colorado Museum of Natural History in Boulder.

Archaeologists have previously dug up hunter-gatherer artifacts in southern Africa that date back as far as 75,000 years. But the artifacts' link to present-day people is unclear; they may be leftovers from cultural experiments that didn't stick, d'Errico says. Scientists can link more recent artifacts — from 20,000 years ago — to today's hunter-gatherers.

But gaps in the archaeological record between the two time periods present "one of the enigmas of southern African archaeology," says archaeologist Christopher Henshilwood of the University of the Witwatersrand in Johannesburg. The new findings help close the gap, he says. "It gives us a much better view of what happened during this time period." 📌



Crafted more than 40,000 years ago, ostrich eggshell beads from South Africa's Border Cave appear to have been made using the same methods that present-day San jewelry makers use. The largest beads are nearly a centimeter in diameter.

FROM TOP: I. HERSHKOVITZ; COURTESY OF LUCINDA BACKWELL

Chicago Doctor Invents Affordable Hearing Aid Outperforms Many Higher Priced Hearing Aids

Reported by J. Page

CHICAGO: A local board-certified Ear, Nose, Throat (ENT) physician, Dr. S. Cherukuri, has just shaken up the hearing aid industry with the invention of a medical-grade, affordable hearing aid. **This revolutionary hearing aid is designed to help millions of people with hearing loss who cannot afford—or do not wish to pay—the much higher cost of traditional hearing aids.**

**"Perhaps the best quality-to-price ratio in the hearing aid industry" – Dr. Babu, M.D.
Board Certified ENT Physician**

Dr. Cherukuri knew that hearing loss could lead to depression, social isolation, anxiety, and symptoms consistent with Alzheimer's dementia. **He could not understand why the cost for hearing aids was so high when the prices on so many consumer electronics like TVs, DVD players, cell phones and digital cameras had fallen.**

Since Medicare and most private insurance do not cover the costs of hearing aids, which traditionally run between \$2000-\$6000 for a pair, many of the doctor's patients could not afford the expense. Dr. Cherukuri's goal was to find a reasonable solution that would help with the most common types of hearing loss at an affordable price, not unlike the **"one-size-fits-most" reading glasses** available at drug stores.

He evaluated numerous hearing devices and sound amplifiers, including those seen on television. Without fail, almost all of these were found to amplify bass/low frequencies (below 1000 Hz) and not useful in amplifying the frequencies related to the human voice.

Inspiration from a Surprising Source

The doctor's inspiration to defeat the powers-that-be that kept inexpensive hearing aids out of the hands of the public actually came from a new cell

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phone he had just purchased. **"I felt that if someone could devise an affordable device like an iPhone® for about \$200 that could do all sorts of things, I could create a hearing aid at a similar price."**

Affordable Hearing Aid With Superb Performance

The high cost of hearing aids is a result of layers of middlemen and expensive unnecessary features. Dr. Cherukuri concluded that it would be possible to develop a medical grade hearing aid without sacrificing the quality of components. The result is the MDHearingAid PRO®, starting well under \$200. **It has been declared to be the best low-cost hearing aid that amplifies the range of sounds associated with the human voice without overly amplifying background noise.**

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The MDHearingAid PRO® has been rigorously tested by leading ENT physicians and audiologists who have unanimously agreed that the **sound quality and output in many cases exceeds more expensive hearing aids.**

Doctors and patients agree: "BEST QUALITY SOUND"

"LOWEST AFFORDABLE PRICE"

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"I have a \$2,000 Resound Live hearing aid in my left ear and the MD HearingAid PRO. in the right ear. I am not able to notice a significant difference in sound quality between the two hearing aids."

— Dr. May, ENT Physician

"We ordered two hearing aids for my mother on Sunday, and the following Wednesday they were in our mailbox! Unbelievable! Now for the best part—they work so great, my mother says she hasn't heard so good for many years, even with her \$2,000 digital! It was so great to see the joy on her face. She is 90 years young again."—Al Peterson

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HIMALAYA RUSH



Scientists scurry to figure out the status of glaciers on the roof of the world **By Devin Powell**

The Himalayas have gotten hot. Mercury in this mountainous region has been climbing, with more warming there in recent decades than in most other places on Earth.

“Temperatures are rising fast at high elevations,” says David Molden, director general of the International Centre for Integrated Mountain Development in Kathmandu, Nepal.

But the heat-up isn’t limited to temperatures. Scientific attention has also intensified, as researchers worried about the fate of glacial ice take a closer look at this remote, inhospitable terrain — sometimes called “the roof of the world.”

In 2007 the Intergovernmental Panel on Climate Change released a report cautioning that “glaciers in the Himalaya are receding faster than in any other part of the world ... and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high.”

That claim has since been retracted. Though it wasn’t based on even the little bit of peer-reviewed data that existed, the commotion surrounding it highlighted the need for new research. Only a handful of Himalayan glaciers were monitored on the ground for mass changes during the 20th century. And when the IPCC report was released, no one had measured and

published the mass of any Himalayan glacier since the year 2000.

Since the embarrassing fumble, scientists have been working at a fever pitch to fill in the knowledge gap. Treks into Asia for long-overdue checkups and analyses of evidence from satellites now provide a window into what’s happening in the Himalayas — and it’s not what many scientists had expected.

Big questions remain, but the emerging picture discredits not only the initial IPCC proclamation, but also the idea that all the glaciers in Asia’s high mountains are responding to climate change in a similar way. Opposite ends of the mountain chain have their own neighborhood

GUILHEM VELLUT

Baltoro Glacier in the Karakoram region of the western Himalayas is one of a handful of glaciers that have appeared to add ice in recent years.

feels, researchers have realized. Glaciers have sweated and suffered in the east, some more so than others. But many in the west have defied rising temperatures, gaining mass in recent years.

“People assume something that’s happening on one end of the Himalayas affects the entire area,” says Mark Williams, a hydrologist at the University of Colorado Boulder. “That’s simply not true.”

An uptick in interest in the Himalayas has also helped overturn unfounded ideas about how much water melting glaciers contribute to Asia’s rivers. Worries that melting could threaten the long-term health of the large rivers crisscrossing India and China haven’t held up to new research.

Unexpected expansion

Like glaciers elsewhere in the world, Himalayan ice caps owe their existence to a delicate hydrological balance. Avalanches from above and precipitation freezing on top of the ice add mass. Sublimation from the surface removes mass. So does melt at a glacier’s leading edge; such melting crests during late summer and early autumn and sends water downslope.

Weather patterns controlling this balance change dramatically throughout the high peaks of Asia. The vast mountain system sprawls thousands of kilometers across Asia’s midsection, touching the wet subtropics of Bhutan in the east and the dry steppes of Afghanistan in the west.

Ice in the west, near Pakistan and Afghanistan, has proved to be surprisingly healthy in recent years. Satellites launched around the beginning of the millennium are seeing signs of growth in the craggy peaks of the Karakoram, where ice caps are fed by year-round snowfall. The leading edges of more than half of the 42 glaciers monitored there from 2000 to 2008 held steady or crept

outward, researchers reported last year in *Nature Geoscience*.

Work from a team in France confirms a slight mass gain overall in the Karakoram range, which extends for about 500 kilometers. Instead of tracing glaciers’ leading edges — which can be deceiving — the researchers worked out changes in mass. They relied on a European satellite that in 2008 mapped the three-dimensional contours of about 5,600 square kilometers of ice.

Compared with a similar map for 2000, made possible by a NASA shuttle mission, the ice was thicker by an average of about 11 centimeters per year, the researchers reported in the May issue of *Nature Geoscience*. Some glaciers at lower altitudes lost ice, but overall the region gained an estimated 110 kilograms of ice per square meter per year (with large uncertainties).

“This is direct evidence that the glaciers in the area have behaved quite well,” says study coauthor Etienne Berthier, a hydrologist at the University of Toulouse.

Glaciologist Kenneth Hewitt saw signs of this behavior more than a decade ago. In the 1990s during a visit to K2, infamous among climbers for being particularly deadly, Hewitt found that the leading edge of the Bualtar Glacier there had crept forward. Ice at the glacier’s high-altitude end had thickened as well. From 1997 to 2002, a dozen other glaciers showed hints of expansion — most of them at high altitudes, more than 7 kilometers above sea level.

Convincing the scientific community that this was a trend proved difficult. Many of these advancing glaciers had

been on the retreat up until the 1980s. In fact, most glaciers around the world had been on the retreat during the 20th century.

“This change appeared very suddenly ... and most people wouldn’t believe it at first,” says Hewitt, a professor emeritus at the Wilfrid Laurier University in Waterloo, Canada, who reported his observations in 2005 in *Mountain Research and Development*.

Though the Karakoram weight gain is now accepted, why the growth spurt is occurring — and whether it will last — remains a mystery. Rain gauges in valleys far below the glaciers have measured an increase in precipitation in recent years. Changing wind patterns could be bringing in more moisture. Or a spate of strangely cool summers in the valleys could be cutting back on melting at the edges.

But there aren’t exactly a plethora of meteorological monitoring stations at higher altitudes where the prospering glaciers live, leaving predictions for the future murky. It’s possible that the ice is simply softening and surging downward, allowing for a temporary increase in mass at the top, says Hewitt. That kind of behavior, common in Alaska and Iceland, typically doesn’t last very long, which means the glaciers could soon start to shrink again.

Eastern retreat

Recent growth of glaciers in the Karakoram stands in stark contrast with pronounced shrinkage elsewhere in the Himalayas, where behavior is closer to scientific expectations. Several lines of new evidence confirm an ongoing trend

Mountain reach

The Himalayas extend thousands of kilometers, covering dry steppes in the west and subtropics in the east. The varying climates may explain why glaciers in the Karakoram region, near K2, show melting patterns different from glaciers to the east, closer to Mount Everest.

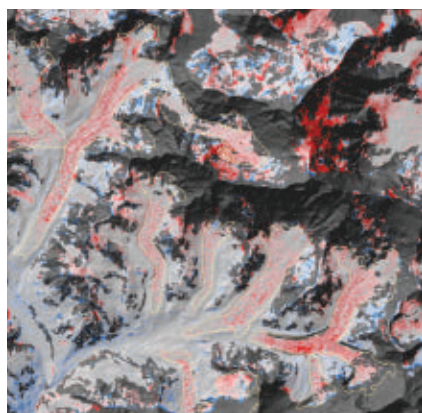


of ice loss in Tibet, Nepal and other countries to the east. There, glacier edges have shed ice faster than it can be replaced.

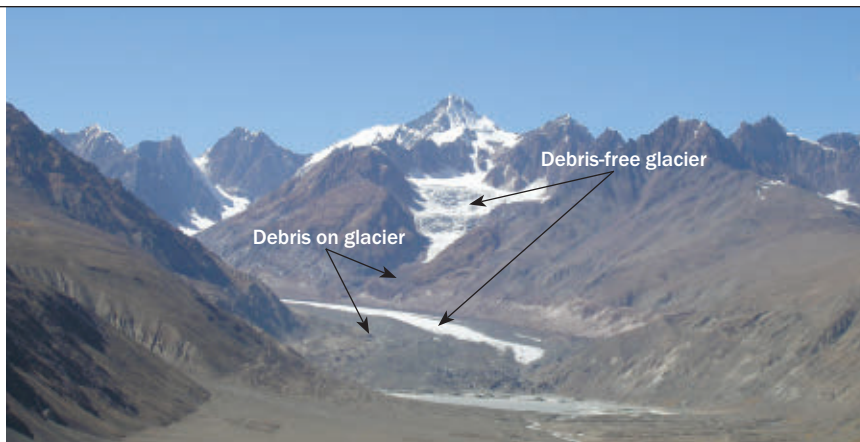
The same study that revealed expanding edges on Karakoram's glaciers also spotted widespread contractions in areas where glaciers are nourished mostly by summer monsoons instead of year-round snow. Between 2000 and 2008, more than 65 percent of monsoon-fed glaciers retreated, though the exact proportion varied from place to place.

Dirty ice seems to have fared better on the whole. Ice caps littered with debris closer to the center of the Himalayas were more likely to hold the line than their cleaner cousins on parts of the Tibetan Plateau, where around 80 percent of glaciers shrank. A coating of fallen rocks may insulate the ice from warm air.

Recent trips to low-lying glaciers have confirmed changes in mass at a few sites to the east of the Karakoram. Koji Fujita and Takayuki Nuimura of Japan's Nagoya University stopped by three glaciers in Nepal. Using GPS devices to map the contours of the ice, the researchers found that ice had disappeared at each site. Melting had accelerated since the 1990s at two of the glaciers, which are "doomed to disappear," the researchers reported last year in the *Proceedings of the National Academy of Sciences*.



Thinning near Everest By comparing data from old U.S. spy satellites with modern satellite measurements, researchers found that 10 glaciers in a region of the eastern Himalayas near Mount Everest thinned between 1970 and 2007.



Dirt insulator At the Mulkila Glacier in India, debris-covered areas are melting slower than clean areas. The dirt may act as an insulator that protects the underlying snow from the warming air.

But contrary to the IPCC's initial claim, glaciers to the east don't seem to be "receding faster than in any other part of the world," says glaciologist Tobias Bolch of the University of Zurich. His measurements show shrinkage at a rate more or less comparable to elsewhere. "Overall, the volume changes of the glaciers are within the average of glaciers across the globe," he says.

Bolch recently pieced together the longest history of a group of Himalayan glaciers ever attempted, thanks to a cache of declassified photos taken by U.S. spy satellites. Started in 1959, the CORONA project kept tabs on Russia and China. Fortunately for the cause of science, the satellites also snapped some stellar shots of glaciers—in stereovision that reveals the 3-D shape of the ice.

Compare these data with modern satellite measurements, as Bolch did, and you can see how the massive glaciers near Mount Everest have changed. Ten ice caps in this area of the eastern Himalayas all thinned between 1970 and 2007, Bolch and colleagues reported last year in *The Cryosphere*.

Like many researchers, Bolch shies away from predicting the glaciers' ultimate fates. He merely points out that not all the eastern ice giants will vanish in the coming decades. Many may survive for a century or more.

As for how much ice is being lost in the whole of the Himalayas, including the Karakoram region, scientists don't yet have a clear picture.

One attempted estimate looked at changes in the area covered by glaciers using old hand-drawn topographic maps, recent satellite images and extrapolations from on-the-ground measurements. In a paper published posthumously in 2010, Mark Dyurgerov reported data suggesting that Asia's high mountains had been losing an average of 55 billion metric tons of ice every year from 2002 to 2006. That's enough ice to sculpt about 57,000 life-size replicas of the Empire State Building.

But the small number of glaciers measured in Dyurgerov's study may not be representative of the tens of thousands of other glaciers in the Himalayas.

"Data on the ground comes from glaciers that are easy to get to. They're at low elevations, and they're small," says Richard Armstrong, a glaciologist at the National Snow and Ice Data Center in Boulder. "Those are likely the ones to be melting the fastest."

Dyurgerov's estimate has been challenged by a relatively new technique for monitoring huge areas of ice from space. Reporting in *Nature* in February, researchers from the University of Colorado Boulder describe measurements from a pair of satellites called GRACE that sense the gravitational pull of ice's mass (*SN: 1/4/03, p. 6*).

Nicknamed Tom and Jerry, the spacecraft chase each other in orbit like their cat and mouse namesakes. Areas of higher or lower gravity push and pull the satellites apart. Large changes in ice over

time show up as noticeable gravitational fluctuations.

Fluctuations from 2003 to 2010 seemed to indicate that the Himalayas had lost only about 5 billion metric tons of ice per year, much less than the 55 billion estimate.

Whether data from this newfangled dousing rod will prove reliable remains to be seen. Critics point out that the twin spacecraft detect all of the gravity variations, not just those due to ice. Ground-water movement could muddy the data.

Watery outcome

Greg Greenwood, executive director of the Mountain Research Initiative in Bern, Switzerland, wouldn't say the new data are cause for celebration. "We still should be concerned because many huge reservoirs of water are wasting away at a significant rate," he says.

Greenwood worries that once shrinking glaciers are gone, Asia will miss the seasonal meltwater they provide. But recent data suggest that not all nations should share that concern. While acquainting themselves with the region's glaciers, scientists have picked up a better understanding of how water flows into and out of the ice. Patterns that again pit east versus west have offered good news for some countries.

Glaciers in the Himalayas are often called Asia's water towers. They store more frozen water than any place on the planet save the titanic ice sheets in the polar regions. Summer melt from Himalayan glaciers streams down to low altitudes, where the rivers fed by the melt offer a source of water for billions of people.

Scientists once thought that glaciers provided most of the summer flow into the rivers of East Asia. Up to 70 percent of water in the Ganges and half or more of that in other major rivers started off as glacial ice in the Himalayas, a 2005 review in *Nature* claimed. In this view, vanishing glaciers would deprive these rivers of an important seasonal water pulse.

But such estimates have now been questioned by Walter Immerzeel, a hydrologist at Utrecht University in the Netherlands. His simulations, based on recent on-the-ground measurements of rainfall and water streaming down from mountains, as well as satellite measurements of snow cover, show that only 9 percent of the Ganges comes from the mountains. China's Yangtze and Yellow rivers carry an even smaller portion of mountain water, Immerzeel and colleagues reported in 2010 in *Science*.

These estimates include both water melting from glaciers and precipitation that never freezes onto the glaciers. When snow melt is removed from the figures, the glacial contribution is left at around 3 percent for the Ganges.

"We now know that glacial melt is a very small component of the water supply in those regions," Immerzeel says.

Calculations by Armstrong also suggest a 2 or 3 percent contribution to the Ganges from glaciers in the east Himalayas.

For all their heft, the ice mounds simply can't compete with the water delivered by monsoons. Every year, the seasonal rains dump tremendous amounts of water into the river basins of India and China.

If all the glaciers disappeared over-

night, the rains would still fall. Without glacial contributions late in the summer and fall, river flows might peak a little earlier in the year. That could affect crops that need water later, but little work has been done to explore this scenario.

The situation is different in arid Afghanistan and Pakistan, where little liquid falls from the sky. In those countries, the traditional wisdom about glacial runoff being important for rivers holds true. Melt from mountain snow and from glaciers makes up more of the Indus River than precipitation that enters the river downstream at low altitudes, Immerzeel's calculations showed.

For the Indus — and for the sprawling irrigation systems that depend on it — the growth of glaciers in the Karakoram could be a double-edged sword. In the long run, it's good news. "We can hope that the Karakoram glaciers will continue to put water into the rivers for a long time," says Berthier.

But the growing glaciers' contributions to the river will probably be smaller in the short run.

Better measurements will be needed to fully tease out the interplay of rain, snow and ice so crucial for Asia's future. Those data could be coming soon. The U.S. intelligence community recently commissioned a study to assess the impact of glaciers on Asia's water security. Other entities with similar concerns, including the U.S. Agency for International Development, have put money into new monitoring efforts. Closer to the source, China and India have launched their own projects.

Everyone is hoping the next IPCC report, the first portion of which is due out in 2013, will offer a clearer portrait of melting glaciers and river water sources.

"The Himalayas seem to have suddenly become quite popular," Armstrong says. "European glaciers have been studied for decades. Now Asia's finally getting up to speed." ■

Explore more

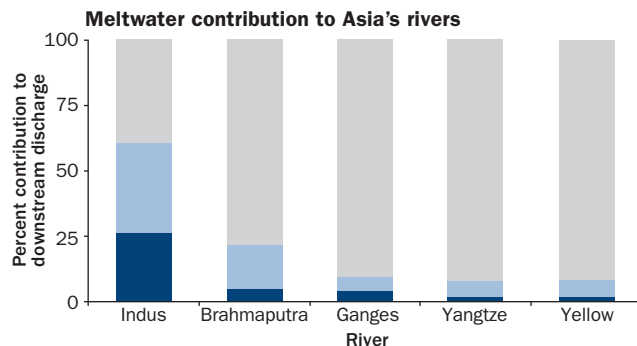
■ Intergovernmental Panel on Climate Change: www.ipcc.ch

Role of melt

Glacial and snow melt's contribution to downstream discharge was relatively small in most rivers in a recent study. Even in the Indus, where the role was bigger, snow melt was more important than glaciers.

■ Glacier melt
■ Snow melt
■ Other

SOURCE: W. IMMERZEEL



Mingling among Stone Age peoples muddies humans' evolutionary story

An ancient finger bone recently landed a genetic sucker punch on scientists studying human evolution. DNA extracted from this tiny fossil, unearthed in Siberia's Denisova Cave, unveiled a humanlike population that interbred with people in East Asia at least 44,000 years ago. Denisovans supplied nearly 5 percent of the genes of native groups now living in Australia, New Guinea and on several nearby islands.

“The question is no longer ‘When did ancient populations such as Neandertals go extinct?’ but ‘What happened to those populations and to modern humans as a result of interbreeding?’” says anthropologist John Hawks of the University of Wisconsin–Madison.

SARAH I. COLEMAN/BA-REPS.COM

ideas about *Homo sapiens*' evolutionary past. A dominant theory holding that humans evolved in Africa and left on neat one-way routes to Asia and Europe has to be revised. Instead, these ancient people must have followed a tangled web of paths taking them to other continents and sometimes reversing course. During these travels, humans encountered Neandertals, Denisovans and probably other humanlike populations that were already traipsing interconnected avenues through Asia and Europe.

With this new picture, two underdog models of human history have gotten new life. Both favor population intersections during extensive travels across ancient landscapes. But one maintains that moving populations were separate species, while a second regards Neandertals and Denisovans as two of possibly many subspecies gradually incorporated into a uniform, modern version of *H. sapiens*.

New genetic evidence and more artifacts that tell Asia's side of the evolutionary story may offer the only chance for settling, or at least narrowing, the dispute.

So long, Eve

Only a few years ago, Neandertals had a scientific reputation as evolutionary also-rans. The seeds of their destruction were sown around 1.7 million years ago when *Homo erectus* — an early *Homo* species — trekked from Africa into Asia. This hardy species, the first human

ancestor to leave Africa, survived until perhaps 200,000 years ago and may have evolved into small-bodied *Homo floresiensis*, or hobbits, in Indonesia.

An *H. erectus* descendant, *Homo heidelbergensis*, originated at least 600,000 years ago — possibly in Africa — and spread across that continent, southern Europe and southern Asia. Between 300,000 and 400,000 years ago, *H. heidelbergensis* evolved into *Homo neanderthalensis* — Neandertals — in West Asia. By 130,000 years ago, *H. heidelbergensis* in Africa had become *H. sapiens*, the humans whose descendants now envelop the globe.

Then the evolutionary hammer came down. Beetle-browed, slope-faced Neandertals bit the dust because they got outcompeted by *H. sapiens* leaving Africa along a series of uninterrupted paths starting around 60,000 years ago. Competition for the same resources created an intense rivalry that discouraged interbreeding, many researchers claimed. Neandertals lost the survival sweepstakes and died out around 30,000 years ago. *H. sapiens* pressed on, ultimately reaching South America by about 14,000 years ago.

A famous 1987 study of mitochondrial DNA, which is passed from mothers to their offspring, spawned this idea — known as the out-of-Africa or recent African origin model. Analyses of mitochondrial DNA sequences in people around the world suggested that a

small number of mothers lucky enough to have had a fertile chain of female offspring up to the present lived in Africa 200,000 years ago. These ancient ladies received the collective nickname Mitochondrial Eve.

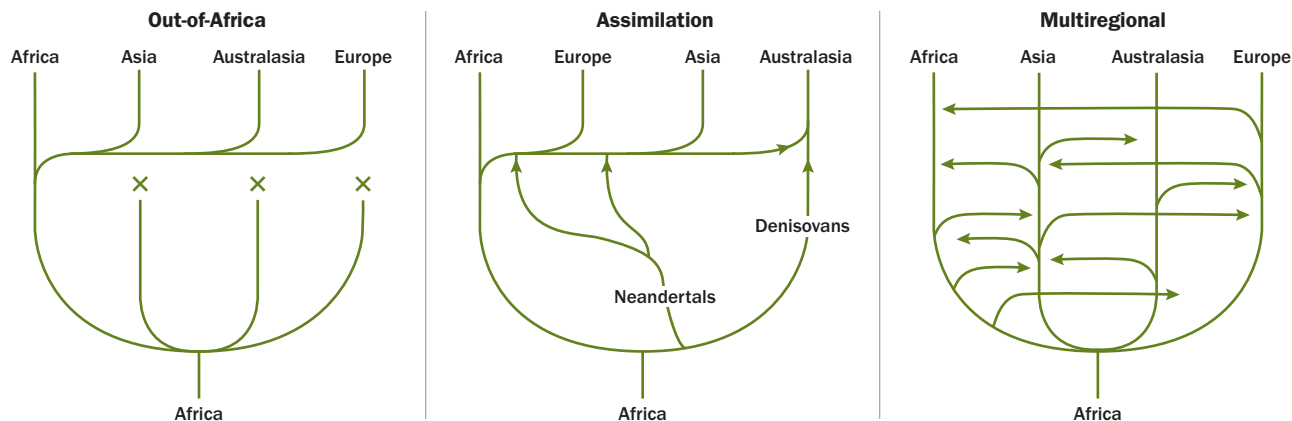
Reports in the mid-1990s that Neandertal mitochondrial DNA markedly differs from that of humans were taken by out-of-Africa proponents as further evidence against Stone Age interbreeding.

But investigators now realize that fast-evolving changes in this brand of human DNA could have erased signs of interbreeding. Evidence from DNA in cell nuclei, which is inherited from both parents and evolves relatively slowly, suggests up to 4 percent of DNA in modern Asians and Europeans was inherited from Neandertals (*SN*: 6/5/10, p. 5). What's more, nuclear DNA retrieved from Stone Age fossils in places cold enough to preserve it gossips about long-ago liaisons between people and another evolutionary relative, the Denisovans (*SN*: 1/15/11, p. 10).

Telltale DNA suggests that many ancient groups migrated back and forth to new areas. Small in numbers, those groups spent generations evolving distinctive physical characteristics in relative isolation before running into other wanderers and interbreeding with them. In this way, various genetic traits got passed among closely related groups over vast territories.

"We were naïve to think that humans

Three views In what has been the dominant model of human evolution (left), *Homo sapiens* evolved in Africa and spread across the globe, replacing other *Homo* populations. With evidence of interbreeding, though, alternative models may get more attention: In one view (center), ancient populations assimilated with a more modern version. Another (right) holds that an abundance of interbreeding kept all groups as part of one species.



Waves of migration

Human ancestors left Africa in a series of pulses beginning nearly 2 million years ago, according to prevailing models. But where they went and when remains unclear. New genetic data may clarify—or further confuse—the picture.

Homo erectus

1. *Homo erectus* evolves in Africa nearly 2 million years ago.
2. Members of the group trek into Asia about 1.7 million years ago.
3. They survive until perhaps 200,000 years ago. Some researchers think *H. erectus* evolves into small-bodied 'hobbits' in Indonesia.

Homo heidelbergensis

1. *Homo heidelbergensis*, an *H. erectus* descendant, originates at least 600,000 years ago in an unknown location and spreads across Africa, southern Europe and southern Asia.
2. Between 300,000 and 400,000 years ago, *H. heidelbergensis* evolves into *H. neanderthalensis*. Neandertals radiate outward.

Homo sapiens

1. By 130,000 years ago an Africa-based line of *H. heidelbergensis* becomes *H. sapiens*. *H. sapiens* leave Africa starting around 60,000 years ago.
2. Members of the species move from Africa into Europe sometime around 50,000 years ago.

just marched out of Africa, killed some Neandertals and populated the world,” says archaeologist John Shea of Stony Brook University in New York.

Remodeling the past

As a key architect of the formerly dominant out-of-Africa model of human evolution, anthropologist Chris Stringer of the Natural History Museum in London was caught off guard by reports of ancient interbreeding. Stringer now accepts that genetic intermingling occurred, but he sees that activity as secondary to genetic evolution that had already largely molded *H. sapiens* in Africa.

In his new book *Lone Survivors*, Stringer dubs his modified perspective a “mostly out of Africa” model. The modified version provides for limited interbreeding before Neandertals and Denisovans died out, but Stringer proposes that these species’ genes offered no major survival advantages to *H. sapiens*.

More than 90 percent of people’s genes today now derive from African *H. sapiens*, Stringer says. As *H. sapiens* left Africa and spread across the globe starting 60,000 years ago, they encountered

and sometimes interbred with other offshoots of *H. heidelbergensis*, including Neandertals and Denisovans. Stringer suspects that occasional interbreeding with ancient humanlike species had a limited effect on the anatomy of *H. sapiens*. Closely related species of baboons and other primates interbreed where population ranges overlap without losing their biological identities, he says.

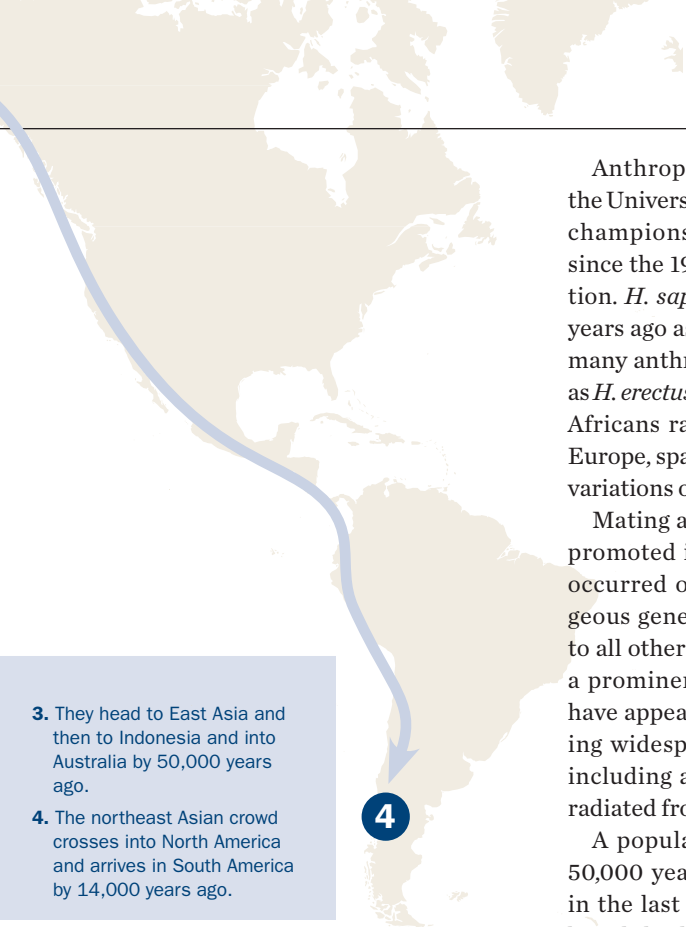
While surviving Neandertal and Denisovan genes caused Stringer to add a dash of interbreeding to his out-of-Africa model, those same DNA revelations delighted theorists who have long regarded interbreeding as a key influence on human evolution. In their view, mobile groups of various *Homo* species—or perhaps of one geographically variable species of ancient *H. sapiens*—must have crossed paths and mated enough to rock each other’s genomes.

“I jumped up and down when the Neandertal genome came out,” says anthropologist Fred Smith of Illinois State University in Normal.

For more than 20 years, Smith and anthropologist Erik Trinkaus of Washington University in St. Louis have

championed a minority view known as the assimilation model. It holds that *H. sapiens* originated in Africa but interbred fairly often with Neandertals and other evolutionary relatives. An increasing number of genetic changes to human DNA over the last 10,000 years, stimulated by mating across much larger populations than in the Stone Age, has erased evidence of far more than a 2.5 percent Neandertal genetic heritage, Smith suspects.

In this view, ancient humans and Neandertals shared a mosaic of skeletal traits despite belonging to separate species. Although researchers have found no genetic evidence of a human impact on Neandertals, Neandertal skulls and jaws from Croatia’s Vindija Cave dating to between 38,000 and 32,000 years ago exhibit a shift toward smaller facial features like those of ancient European *H. sapiens*, Smith reported in April in Portland, Ore., at the American Association of Physical Anthropologists’ annual meeting. People reached Europe by at least 40,000 years ago and could have changed the look of Vindija Neandertals via interbreeding.



3. They head to East Asia and then to Indonesia and into Australia by 50,000 years ago.

4. The northeast Asian crowd crosses into North America and arrives in South America by 14,000 years ago.

Traces of interbreeding on Vindija fossils fit a scenario in which African *H. sapiens* could reproduce with any other *Homo* population, including those often regarded as different species, says anthropologist John Relethford of the State University of New York at Oneonta.

Hundreds, perhaps thousands, of human and humanlike groups moved across Africa, Asia and Europe during the Stone Age, Relethford says. Some groups mated with others, some kept their distance and others attacked competitors. An unknown number of mobile bands died out.

“We’re trying to reconstruct a big evolutionary grid from a small number of data points,” Relethford says.

While assimilationists see different *Homo* species moving along that grid and sometimes interbreeding, another perspective lumps Neandertals, Denisovans and others into a single species that evolved on different continents beginning nearly 2 million years ago. Far-flung, physically distinctive human groups interbred enough during their travels to keep *H. sapiens* genetically glued together, these researchers propose.

Anthropologist Milford Wolpoff of the University of Michigan in Ann Arbor champions this perspective, known since the 1930s as multiregional evolution. *H. sapiens* arose almost 2 million years ago as an African population that many anthropologists mistakenly label as *H. erectus*, Wolpoff says. Those ancient Africans rapidly moved into Asia and Europe, spawning a series of anatomical variations on the *H. sapiens* theme.

Mating across *H. sapiens* subspecies promoted intercontinental unity, and occurred often enough that advantageous genes in one population spread to all others. In this way, a trait such as a prominent chin, for example, could have appeared in Africa before becoming widespread, whereas other traits, including a high forehead, could have radiated from an Asian homeland.

A population explosion that began 50,000 years ago and has accelerated in the last 10,000 years, accompanied by adults living progressively longer, prompted so much breeding across populations that human races disappeared altogether, Wolpoff asserts. People now encompass a uniform species with more minor regional variations in skin color, stature and other characteristics.

“I think humanity included Neandertals, although many disagree,” says Wisconsin’s Hawks.

Genetic rescue

Putting together the genetic bits and pieces will be a complex task. In a recent twist, a team led by Sarah Tishkoff of the University of Pennsylvania reports that three hunter-gatherer groups currently living in Africa carry genetic signatures that may have been produced by interbreeding with a now-extinct African *Homo* species 30,000 to 70,000 years ago. But without any genetic material from this mysterious Stone Age species, it’s hard to make any firm claims, Tishkoff and colleagues report in the Aug. 3 *Cell*.

A fuller picture of human evolutionary history clearly awaits further ancient DNA evidence. Research teams around the world are now competing to

obtain fingernail-sized bone samples from museum-held *Homo* fossils. Scientists hope to build a genetic record of human ancestors comparable to the existing fossil record.

A group led by evolutionary geneticist Johannes Krause of the University of Tübingen, Germany, is trying to remove and reassemble nuclear DNA from the bones of roughly 20,000-year-old people in Europe. If successful, that effort will provide the first look at whether Stone Age humans carried more Neandertal genes than people today do. “It’s a completely open question whether more interbreeding occurred in the past than what we’ve found so far,” Krause says.

Preliminary evidence that Neandertals and Denisovans passed beneficial genes to *H. sapiens* suggests interbreeding was not only common but also crucial to survival. A 2011 investigation led by Stanford University geneticist Peter Parham concluded that several genes involved in the body’s disease-fighting immune system spread from Neandertals and Denisovans to humans and are now common in some parts of Asia. Further support for genetically advantageous mating across species would be bad news for Stringer’s mostly out-of-Africa model.

Other researchers comparing genetic contributions in people around the world today are getting a handle on whether Denisovan and Neandertal genes caught on in some populations more than others.

Krause and his colleagues recently found Denisovan DNA in Australian Aborigines and natives of several Oceanic islands but not in residents of mainland Southeast Asia. Denisovans may have gone from Southeast Asia to Oceanic islands where they interbred with people who eventually reached Australia on canoes or rafts, proposes Krause, who formerly worked with a team that analyzed the genetic blueprint of Neandertals and Denisovans. The finding would explain why native groups now living in Australia, New Guinea and nearby islands display slightly different amounts and types of Denisovan DNA.

Southeast Asians may, however,

possess roughly 1 percent Denisovan ancestry, say evolutionary geneticists Pontus Skoglund and Mattias Jakobsson of Uppsala University in Sweden. A small genetic connection between Southeast Asians and Denisovans emerged when comparing the genetic instruction books of a larger sample of living people with the ancient Siberian genome, the researchers reported in a 2011 paper.

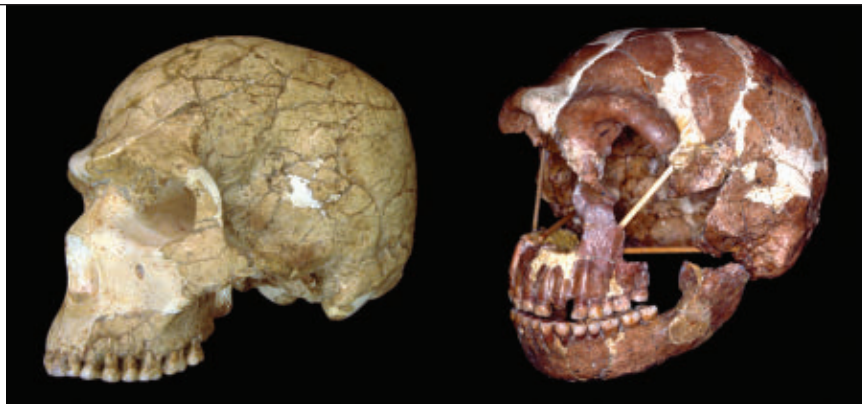
If that finding holds up, then Denisovans interbred unevenly with different groups of ancient humans. So did Neandertals, but on a geographically grander scale, says Hawks. By consulting data that other researchers posted on an open-access website, he has compared Neandertal DNA with genomes from about 1,000 individuals living in different parts of the world.

Small differences in Neandertal ancestry appear in people from different populations, Hawks reported at the physical anthropology meeting. He believes that his findings are consistent with multi-regional evolution: Physically distinctive groups of *H. sapiens* occasionally expanded their ranges and sometimes mated when they crossed paths, leaving an uneven mark on ensuing generations. A supporter of the mostly out-of-Africa approach would probably treat Hawks' findings as regional blips in what were minimal genetic exchanges.

Europeans carry an average of about 2.5 percent Neandertal DNA, while the Chinese carry 3 percent, Hawks reported. And slightly more Neandertal DNA appears in northern Chinese than in southern Chinese. Africans possess an average of less than 1 percent Neandertal ancestry. Regardless of exactly how much interbreeding occurred during the Stone Age, Neandertals seem to have left an uneven genetic mark.

Going East

Ongoing investigations of fossils and stone tools, especially in Asia, will have their own story to tell. Numerous long-distance treks from Africa to Asia by some of the earliest toolmakers now appear undeniable. A growing number of archaeological sites, especially in China,



Two skulls from nearby Israeli caves contain a mix of modern human and Neandertal traits. The left skull dates to roughly 100,000 years ago and is usually attributed to modern *H. sapiens*. The right skull, from the same time, is considered Neandertal.

document the presence in East Asia of teardrop-shaped hand axes made by *H. erectus* starting 1.7 million years ago, says Harvard University archaeologist Ofer Bar-Yosef. *H. erectus* fossils and tools date to the same time on the Indonesian island of Java.

New finds show that Neandertals, like *H. sapiens*, also went on plenty of intercontinental road trips, so the two species could have tangoed over tens of millions of square kilometers. Artifacts recently discovered in China resemble tools associated with Neandertals in Europe and West Asia, Bar-Yosef says. Neandertals aggressively expanded their territory eastward beginning perhaps 75,000 years ago, before humans had left Africa in significant numbers, he and Anna Belfer-Cohen of Hebrew University in Jerusalem propose in an upcoming *Quaternary International*.

Trinkaus also sees signs that thick-boned, relatively large Stone Age people who lived more than 50,000 years ago, a group of archaic *H. sapiens*, interbred fairly often with Neandertals in what's now North China. Archaic human fossils from that region, mainly described in Chinese publications, look like Neandertals in some respects. Trinkaus and his colleagues have also reported that a 100,000-year-old human jaw and two associated teeth found at South China's Zhiren Cave display a mix of archaic and anatomically modern traits.

Some researchers argue that the meeting of biologically related species

in ancient East Asia was also a meeting of equal minds. Implements created by both species range from simple flakes struck off stones to finely chiseled blades, Shea says. *Homo* populations apparently adapted toolmaking to environmental conditions rather than crafting increasingly complex tools over time. Contrary to conventional archaeological thinking, no tool style distinguishes Neandertals from *H. sapiens*, Shea argues.

His scenario suggests that sophisticated thinking needed for manufacturing diverse toolkits emerged 200,000 years ago or more in both species. That's a prospect welcomed by assimilation and multiregional theorists alike. An opposing view — congenial to mostly out-of-Africa advocates — holds that *H. sapiens* alone experienced a major mental leap between 70,000 and 50,000 years ago.

No one yet knows whether Asia harbors a mother lode of stones, bones and ancient DNA capable of untangling *H. sapiens*' mental and physical evolution, or the movements of myriad ancient groups. For now, Asia's Stone Age is as enigmatic as the tangled roots of its human inhabitants.

"Ten years ago, we would not have expected the extent of the mystery that has emerged," Hawks says. ■

Explore more

■ Evolutionary genetics from the Max Planck Institute for Evolutionary Anthropology: www.eva.mpg.de/genetics

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Uncommon

People have a surprising number of rare genetic variants

By Tina Hesman Saey

If variety lends life flavor, then humans are kicking things up to a previously unrecognized notch on the spice-o-meter.

New efforts to decipher the genetic blueprints of thousands of people have turned up more than half a million tweaks in human DNA, many more than scientists expected. Most of these tweaks are new to science, and a majority fall into a class called “rare variants,” found in 0.5 percent of the population or less. Some of the variety recently uncovered is so uncommon that it shows up in people living in a single geographic region, or even in only one person.

Despite their limited spread, the newly discovered rare variants could profoundly affect susceptibility to disease or how well drugs work. They may also help researchers reconstruct recent human migrations around the world.

For years, scientists have been examining the chemical units of DNA called nucleotides that act as letters in the human genetic instruction book. So researchers thought they had a good handle on how often to expect single-letter changes in the A's, G's, T's and C's in that book. Such changes stem from errors in copying and are spotted via comparison with some majority-rule blueprint. They can go by terms like “single nucleotide polymorphisms” or “mutations” depending on where and when they show up.

When looking at 202 genes predicted to be important in diseases from 14,002 people, John Novembre of the Univer-

sity of California, Los Angeles and colleagues unearthed five times as many rare genetic variants as expected.

Based on what's known about human diversity, the researchers thought they would find one letter change for every 90 nucleotides. Instead, the team reported in the July 6 *Science*, a variant showed up for every 17 nucleotides. Not only did these variants include more rare ones than expected, but also more really rare ones. About 74 percent of the rare variants are practically secret family recipes. Others reveal the distinct flavor of geographic regions, much like wines or cheeses.

Figuring out how these exotic variants contribute to disease will probably be more challenging than it has been for widespread tweaks. Currently researchers rely on statistics to sort out links between common variants and disease, but rare variants won't make the cut in these types of analyses. Instead of linking a particular DNA change to a disease, scientists will probably have to pinpoint where variants strike to see if certain genes are hit over and over again.

“The hope is that even though the variants themselves will be unique to each population, the underlying genes ... will be the same,” says Jeffrey Kidd, a human population geneticist at the University of Michigan in Ann Arbor.

Probing the rare

Combing the roughly 3 billion DNA units that make up each person's genetic blueprint is a daunting task. Novembre's team

focused on just a tiny portion: 864,000 DNA units containing 202 genes. Another team took a broader look, concentrating on about 60 million units containing 15,585 genes. The project was ambitious, reading each of those genes for thousands of people 100-plus times to be sure every letter was correctly identified.

“This is, I think the technical term is, a ginormous project,” says study coleader Joshua Akey, a population geneticist at the University of Washington in Seattle.

People in the study carried an average of 13,595 single DNA nucleotide variants, with about six rare variants for every common one, Akey and colleagues reported in the July 6 *Science*. Rare variants were about four times as numerous as scientists expected.

A typical participant had more than 300 genes carrying variants that impair the function of the protein produced by that gene. In almost all those cases, the culprit was a rare variant. Rare variants probably tend to be the bad ones because natural selection weeds out harmful alterations before they can become common, Akey says. Rare, adverse variants found in the study probably arose recently, giving evolution little chance to counteract them.

Although many of these rare variants are predicted to be harmful, their youth makes them a treasure trove for scientists reconstructing how humans have migrated around the world. Population geneticists have used common genetic variants to decipher human movement



before, but most of that data represents ancient history. A variant common enough to appear in 5 percent or more of the population is probably more than 10,000 years old, says Alon Keinan, a computational biologist and human population geneticist at Cornell University.

But rare variants are younger, with new ones popping up in every generation, so they can tell geneticists what has happened in the last several hundred to several thousand years. That's a time period scientists know little about, genetically speaking.

Tracing the past

Archaeological finds and, more recently, census data reveal that the human population has been booming, expanding from a few million people 10,000 years ago to more than 7 billion today. But,

"the jury is still somewhat out on the exact signature history has left on our genetic variation," Keinan says.

Previous studies had suggested that populations grew in size but not in genetic diversity, with variants squeezed out by natural selection and population bottlenecks as humans colonized the world. Data compiled from a small number of people seemed to indicate that human genetic diversity had remained fairly stagnant for the last 30,000 years or longer. So genetic records could outline basic migration paths showing that humans moved from point A to B, but wouldn't record all the interesting byways and side trips along the way.

But it now looks like those studies underestimated the number of rare variants in the human population. With colleague Andrew Clark, Keinan reported in the May 11 *Science* that rapid population growth has produced an abundance of rare genetic variants in humans.

Studies of thousands of people reveal that a measure of genetic diversity that includes new variants has grown at a rate of 5 to 14 percent per generation for at least the last 900 to 2,800 years. Armed with the new information, Keinan and Clark simulated different scenarios for the colonization of Europe. Simulations that included bottlenecks and population growth mirrored patterns of rare variants seen in modern Europeans better than did scenarios that neglected population expansion.

The pair's measurements of genetic

diversity offer a broad view, mostly of Europeans. Novembre advocates drilling deeper to look at rare variants regionally or in certain ethnic groups.

Populations sampled so far (all three recent studies focused mainly on Europeans and African-Americans) have had different patterns of diversity, shaking up population geneticists' assumptions that one measure of diversity should fit all human groups. "There isn't one number you can plug in and predict how much diversity we'll see," Novembre says.

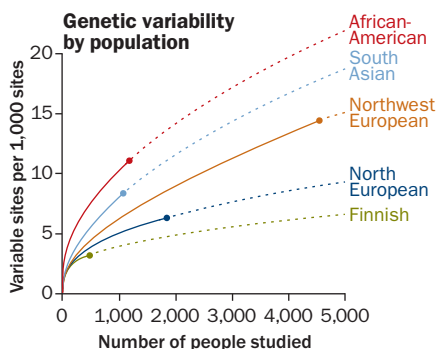
As scientists begin studying smaller and smaller groups of people, they may discover yet different levels and patterns of variation. In fact, researchers may need to examine every single person on the planet to find all the diversity.

Previous studies that didn't consider population growth predicted that scientists would find all the new variants they could expect to uncover after examining the genetic instruction books of 1,000 people. One more genome wouldn't add much to the mix.

But by Keinan and Clark's calculations, which take into account variants introduced as a population grows, a 1,001st genome would yield at least a thousand new variants, making the flavor of human diversity ever more complex. ■

Explore more

■ J.A. Tennessen *et al.* "Evolution and functional impact of rare coding variation from deep sequencing of human exomes." *Science*. July 6, 2012.



SOURCE: M.R. NELSON *ET AL.*/SCIENCE 2012

Genetic stripes Different populations show differing degrees of genetic variability. As scientists study more people, they expect the number of variants uncovered will continue to rise (dotted lines show predictions).

No Time to Lose

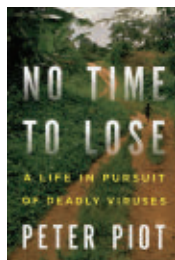
Peter Piot

When smallpox was eradicated in the 1970s, many people thought it was “game over” for infectious diseases as global threats. How wrong they were.

Peter Piot, then a young physician-researcher, was in the right place at the right time, if you can call it that. Piot was working in Belgium in 1976 when his laboratory received two vials of blood from a victim of a disease outbreak in Africa. They arrived in a thermos, and no one knew they contained a deadly virus.

So the researchers just opened the thermos. “Nowadays it makes me wince just to think of it,” Piot writes. “Sure, we were wearing latex gloves [but] no suits or masks of any kind.” Piot and the others traced the mystery pathogen back to Yambuku, Zaire, the outbreak’s epicenter, and from there tracked its spread. The team named the virus for a nearby river, the Ebola.

Africa would define Piot’s career. He shifted his attention to sexually transmitted diseases, and by 1983, when a condition called AIDS was showing up in U.S. gay men, he was back in Zaire. Doctors there had been seeing AIDS-like cases for years, so he gathered blood samples and sent them to the French lab of Luc Montagnier, who



had discovered what would be named the HIV virus. When the samples matched, HIV and Africa were forever linked. Life in the field is more interesting than behind a desk, and the book lags when Piot returns to Europe in the 1990s to become the first director of UNAIDS, the United Nations AIDS agency. But Piot has lived a life less ordinary, and it’s presented well. — *Nathan Seppa*
W.W. Norton & Co., 2012, 304 p., \$28.95

The Marvelous Learning Animal

Arthur Staats

As the inventor of the time-out procedure for disciplining misbehaving kids, Staats transformed modern parenting. Now he wants to give a time-out to popular biology-based explanations of human behavior. Genes and brains orchestrate bodies, he argues, but don’t determine behavior or inner states such as intelligence and cruelty.

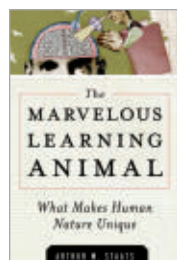
Brain activity that characterizes poor readers, for example, often reflects how those individuals have learned to deal with written material, Staats says, not an inherently wayward brain. Misguided reinforcement of children’s behavior by parents and teachers results in learning disabilities, emotional disorders and even autism symptoms, in his view.

Staats is a behaviorist who, unlike B.F. Skinner, regards emotions as key tar-

gets for shaping behaviors. Millions of years of evolution have yielded people who learn via positive and negative reactions to experiences, Staats argues. Repertoires of conditioned responses, such as learning the meanings of words, provide the foundation for more complex achievements such as writing stories and planning cities. No other animal snowballs knowledge this way.

Many of these ideas are not as radical as Staats seems to think. Biological determinism has ardent critics. Plenty of psychologists study how children and adults learn various tasks, for instance, focusing on the fit between individual characteristics and learning situations. And some anthropologists look back further, arguing that the rise of language a million or more years ago led to complex human cultures.

Sets of conditioned behaviors alone are unlikely to explain creativity and innovation. But Staats’ point that scientists need to learn more about learning is a good one. — *Bruce Bower*
Prometheus Books, 2012, 402 p., \$27



101 American Geo-Sites You’ve Gotta See

Albert B. Dickas

This handy guide

has plenty of labeled photos and diagrams to help you find geological sites of interest in all 50 states.

Mountain Press, 2012, 250 p., \$24



Is American Science in Decline?

Yu Xie and

Alexandra A. Killewald

Two sociologists look at fears of falling behind the global competition and find that U.S. research

is changing but is still in good health. Harvard Univ., 2012, 230 p., \$45



Gravity

Brian Clegg

A history of attempts to understand the universe’s most mysterious force also explores gravity’s importance in people’s everyday lives.

St. Martin’s, 2012, 336 p., \$25.99



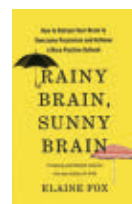
Gifts of the Crow

John Marzluff and
Tony Angell

Tales of crows’ amazing feats are complemented by original artwork in this look

at the birds’ intelligence.

Free Press, 2012, 289 p., \$25



Rainy Brain, Sunny Brain

Elaine Fox

An overview of recent research suggests ways to take advantage of the brain’s malle-

ability to change patterns of thinking. Basic Books, 2012, 256 p., \$26.99

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Higgs affects inertia, not gravity

In the articles on the Higgs field in the July 28 issue, the Higgs boson was described as giving rise to the mass and therefore the inertia of particles, and the articles said the Higgs causes particles to “resist motion.” Newton’s first law states that inertia or mass is the property of matter that resists *changes* in motion, whereas drag is the resistance to motion. Can you explain the apparent conflict between your description and Newton’s first law?

Sherman S. Steadman, via e-mail

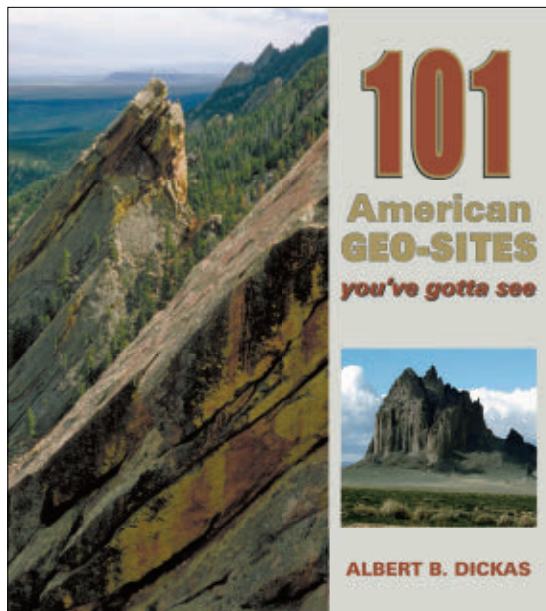
I am confused about this statement in “Behind the Higgs” (*SN*: 7/28/12, p. 26): “With the Higgs field, physicists completed the standard model, which accurately describes the behaviors of all known particles and forces (except gravity).” Elsewhere the articles explain how the Higgs field infuses certain particles with mass. Isn’t mass the basis of gravity — massive entities attracting each other?

Sam Henrie, via e-mail

“Resistance to motion” as a description of inertia is imprecise shorthand for “resistance to change in state of motion,” as mentioned in “Behind the Higgs”: “Such resistance to motion (or more precisely, change in motion) is the very definition of inertia, which in turn is the very definition of mass.” Inertial mass is conferred upon particles by the Higgs; according to Einstein’s general relativity, inertial mass is indistinguishable from gravitational mass. Einstein also showed, however, that gravitation acts not just on mass but on energy. So even though a photon has no mass, its energy distorts spacetime and its path follows distortions in spacetime. So while the Higgs explains why some subatomic particles described by physics’ standard model possess mass, it does not reconcile general relativity with the quantum mechanics that underlies the standard model. —Tom Siegfried

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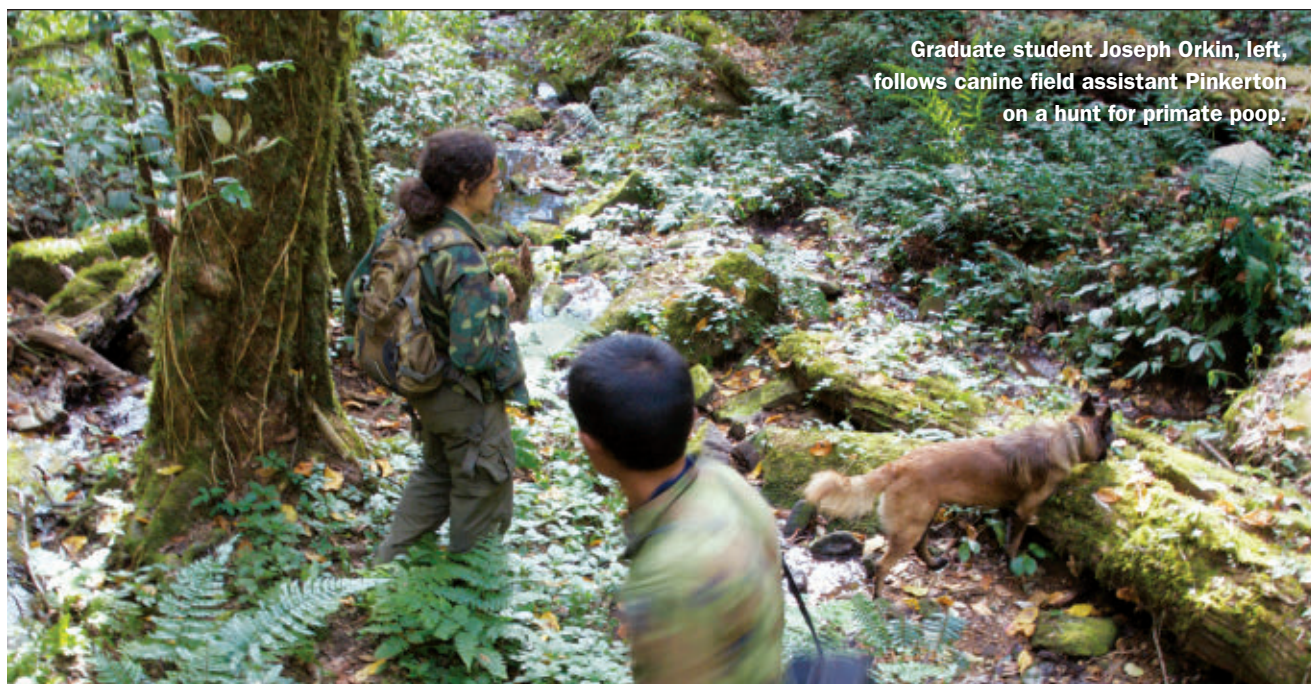
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Graduate student Joseph Orkin, left, follows canine field assistant Pinkerton on a hunt for primate poop.

Saving primates with a dog and scat

Joseph Orkin has found an unusual way to study highly endangered — and highly elusive — primates in southwestern China. Orkin hikes into isolated mountaintop forests accompanied by a four-legged assistant who avidly sniffs out scat left by black-crested gibbons and Phayre's leaf monkeys.

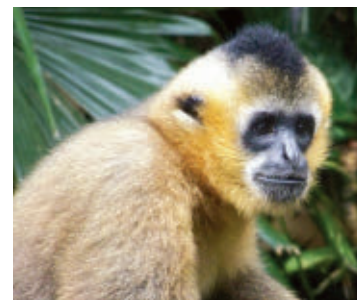
Orkin's fuzzy-faced helper answers to the name Pinkerton (like the detective agency). A Belgian Malinois with that dog breed's characteristic high-energy smarts, Pinkerton has been trained to recognize the odor of poop from the two threatened primate species. Orkin follows Pinkerton through the forest, and Pinkerton follows his nose to droppings hidden in the undergrowth. All the pooch wants in return is an occasional play break with his favorite ball, especially after flopping down to alert Orkin to some fecal prey.

"What I'm doing sounds a little crazy to some scientists, but Pinkerton has worked out well," Orkin says. Currently a graduate student in anthropology at Washington University in St. Louis, Orkin is also affiliated with China's Kunming Institute of Zoology.

Orkin and Pinkerton hear but rarely see gibbons and monkeys, as the animals usually flee from intruders. But one primate's dung is another's data. DNA extracted from retrieved poop will allow Orkin to reconstruct the recent evolution of each species, determine the frequency of potentially dangerous inbreeding in declining populations and formulate conservation strategies.

Two years ago, Orkin heard about U.S. groups that train scat-sniffing dogs for surveys of rare animals. Soon after, he bought Pinkerton from a Chinese police official who trains bomb-sniffing dogs, including those used in the 2008 Beijing Olympics. The official trained Pinkerton to associate the smell of gibbon and monkey droppings (supplied by Orkin) with playtime. Orkin then continued Pinkerton's education in the field.

The gregarious dog will return to the United States with Orkin in a year or two when the research in China is complete. —*Bruce Bower*



By collecting DNA from droppings, scientists can see if populations of the endangered black-crested gibbon (female above) are becoming genetically isolated.

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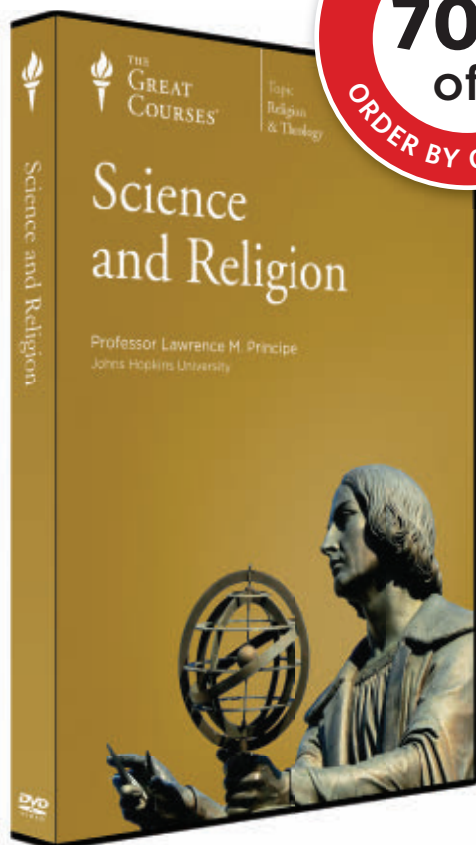
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