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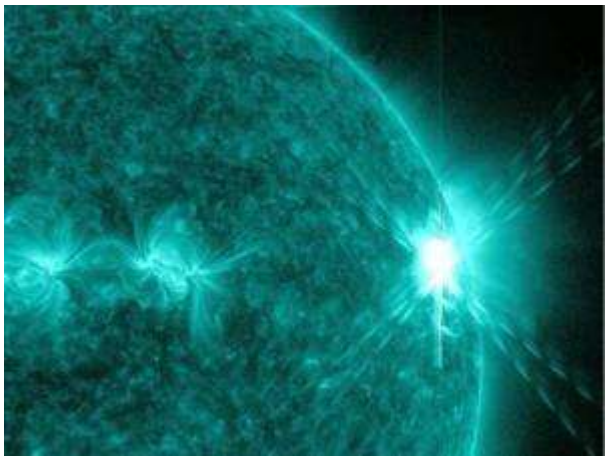
Solar Flares: What Does It Take to Be X-Class? Sun Emits an X-Class Flare On August 9, 2011



An X-class flare began at 3:48 AM EDT on August 9, 2011 and peaked at 4:05 AM. The flare burst from sun spot region AR11263, before it rotated out of view. The image here was captured by NASA's Solar Dynamics Observatory in extreme ultraviolet light at 131 Angstroms. (Credit: NASA)

ScienceDaily (Aug. 9, 2011) — Solar flares are giant explosions on the sun that send energy, light and high speed particles into space. These flares are often associated with solar magnetic storms known as coronal mass ejections (CMEs). The number of solar flares increases approximately every 11 years, and the sun is currently moving towards another solar maximum, likely in 2013. That means more flares will be coming, some small and some big enough to send their radiation all the way to Earth.

The biggest flares are known as "X-class flares" based on a classification system that divides solar flares according to their strength. The smallest ones are A-class (near background levels), followed by B, C, M and X. Similar to the Richter scale for earthquakes, each letter represents a 10-fold increase in energy output. So an X is ten times an M and 100 times a C. Within each letter class there is a finer scale from 1 to 9.

C-class and smaller flares are too weak to noticeably affect Earth. M-class flares can cause brief radio blackouts at the poles and minor radiation storms that might endanger astronauts.

And then come the X-class flares. Although X is the last letter, there are flares more than 10 times the power of an X1, so X-class flares can go higher than 9. The most powerful flare measured with modern methods was in 2003, during the last solar maximum, and it was so powerful that it overloaded the sensors measuring it. The sensors cut out at X28.

The biggest X-class flares are by far the largest explosions in the solar system and are awesome to watch. Loops tens of times the size of Earth leap up off the sun's surface when the sun's magnetic fields cross over each other and reconnect. In the biggest events, this reconnection process can produce as much energy as a billion hydrogen bombs.

If they're directed at Earth, such flares and associated CMEs can create long lasting radiation storms that can harm satellites, communications systems, and even ground-based technologies and power grids. X-class flares on December 5 and December 6, 2006, for example, triggered a CME that interfered with GPS signals being sent to ground-based receivers.

NASA and NOAA -- as well as the US Air Force Weather Agency (AFWA) and others -- keep a constant watch on the sun to monitor for X-class flares and their associated magnetic storms. With advance warning many satellites and spacecraft can be protected from the worst effects.

On August 9, 2011 at 3:48 a.m. EDT, the sun emitted an Earth-directed X6.9 flare, as measured by the NOAA GOES satellite. These gigantic bursts of radiation cannot pass through Earth's atmosphere to harm humans on the ground, however they can disrupt the atmosphere and disrupt GPS and communications signals. In this case, it appears the flare is strong enough to potentially cause some radio communication blackouts. It also produced increased solar energetic proton radiation -- enough to affect humans in space if they do not protect themselves.

There was also a coronal mass ejection (CME) associated with this flare. CMEs are another solar phenomenon that can send solar particles into space and affect electronic systems in satellites and on Earth. However, this CME is not traveling toward and Earth so no Earth-bound effects are expected.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA/Goddard Space Flight Center.

http://www.sciencedaily.com/releases/2011/08/110809162011.htm

'Uneducated Guesses'

August 3, 2011

What if the educators making important decisions about schools and colleges are acting too much on their guts and not enough based on actual evidence?

To Howard Wainer, that's no hypothetical. He is convinced that, from elementary school through higher education, the best evidence is frequently ignored. His new book, *Uneducated Guesses: Using Evidence to Uncover Misguided Education Policies*, is about to appear from Princeton University Press. Parts of the book relate to current controversies over standardized testing and the Advanced Placement Program. (Other parts are more focused on K-12.)

Wainer is critical of the movement to make the SAT optional in college admissions, and argues that students who don't submit SAT scores perform worse in college than do those who submit the scores. Of the AP program, he is a fan in general, but he writes that -- despite calls from some to expand AP everywhere -- there are many school districts where students' chance of success is so low that the investment in AP doesn't make sense.

While Wainer has a long history in the testing field -- he was a research scientist at the Educational Testing Service for 21 years -- he said that his work was not financially supported by ETS or the College Board (though both groups provided access to data). Since leaving ETS, Wainer has been a research scientist at the National Board of Medical Examiners and an adjunct professor of statistics at the Wharton School of the University of Pennsylvania.

Asked for his overall views on testing, Wainer said that he is in favor of "competent testing," but not all testing. He said his view on statistics and education policy is reflected in Samuel Johnson's quote: "The modern method is to count. The ancient one was to guess."

Going SAT-Optional

The movement to drop SAT and ACT requirements for applicants has grown in recent years, with many colleges reporting that they lose nothing in academic quality or performance (as measured by graduation rates, for instance) from going test-optional. Further, many colleges that have dropped the requirement have reported that the very act of doing so results in increases in the number of minority applicants.

Wainer attacks this logic by making comparisons of students who do and do not submit SAT scores and enroll at the colleges that do not require the SAT. In the case of Bowdoin College, which does not require testing, but for which most applicants have taken the SAT, he compares the academic performance in college of those who did and did not submit scores. For four other colleges, he looks at the performance of the minority of students who submitted ACT scores instead of SAT scores. (The College Board and ACT agree on a "concordance table" that theoretically converts scores, but applicants tend to submit the scores that make them look best, and those who take both tests don't necessarily score as the table would suggest.)

In the case of Bowdoin, all of the members of the Class of 1999 took the SAT -- even though only 72 percent submitted their scores. Using data obtained from the College Board, Wainer said that those who submitted scores, on average, outperformed those who didn't on the SAT -- 1323 to 1201. So he writes that those who didn't submit made a rational decision, as their scores might have resulted in their rejection.

But then he tracked the academic performance of both groups of students in their first year (the first year being key, since the College Board says that the SAT predicts first-year academic success). He found that

those who did not submit scores received grades in the first year that were 0.2 points lower than those of students who submitted scores. This suggests, he writes, that the SAT does predict academic performance in a meaningful way.

Then Wainer examined four colleges that let students submit SAT or ACT scores, and for which first-year grades were also available: Barnard and Colby Colleges, Carnegie Mellon University and the Georgia Institute of Technology. At all of these institutions, the students who submitted SAT scores had slightly better first-year grades than those who didn't.

Wainer argues that these and other data suggest that colleges that seek to enroll those who will perform best in their first year are acting against the evidence when they make the SAT optional. "Making the SAT optional seems to guarantee that it will be the lower-scoring students who perform more poorly, on average, in their first-year college courses, even though the admissions office has found other evidence on which to offer them a spot," he writes.

Robert Schaeffer, public education director of the National Center for Fair and Open Testing, which has encouraged colleges to drop SAT requirements, said that these findings don't challenge the reality that scores of colleges have done in-depth studies in recent years and found that dropping the test requirement has no impact on retention or graduation rates. He noted that Wainer's career "has been spent inside the testing industry" and said that he "ignores evidence" from many other colleges.

Schaeffer said he doubted the findings would "have any significant impact on the continued growth of the test-optional movement."

Skepticism on AP Growth

Another chapter in the book focuses on the AP program, which, on the whole, Wainer supports. He sees the program challenging some students to work harder and learn more than they otherwise would in high school. "AP classes typically have a lot more meat to them," he said, and many high schools assign the best teachers to them. But the issue he explores -- failure rates -- runs counter to some of the AP hype about how quickly (and where) the program can grow.

Failure rates (scores below a 3 on the 1-5 scale) have been attracting increasing attention. Last year, *USA Today* and *The Dallas Morning News* ran long articles looking at increases in the rates. Between 2001 and 2009, the passing rate on AP exams fell from 60.8 to 56.5 percent -- as the number of students who took an AP exam increased from 17 percent to 26 percent of the public high school population. As the critical articles noted, however, some high schools had very low pass rates, while others had very high rates.

At the time the articles came out, College Board officials criticized them, saying that the increase in participation made an increase in the failure rate almost inevitable, since a broader cross-section of the high school population (and a less elite subset) was taking the tests. Further, College Board leaders said at the time that AP programs encourage higher standards and so benefit a school even with low passing rates.

Wainer argues that while many students can benefit from AP (including plenty not currently participating), something is seriously wrong when schools report very high failure rates. He also finds a clear relationship between PSAT scores and subsequent success on many AP exams. So he argues that at high schools with relatively low PSAT scores, there are very few benefits to a major expansion of AP.

"A lot of schools use as their criterion of success the number of students who take AP courses. I think they should use the number who pass," he said. It's not that students in AP courses don't learn anything, even if

they don't pass, he said. "It's a triage decision. These schools have limited resources," so to put those resources into AP, with a low success rate, doesn't make sense.

While the College Board has in fact boasted about rising participation rates, Trevor Packer, the head of the AP program, said in an interview that he agreed with Wainer's arguments. There has been "a rush to AP" that isn't always appropriate, Packer said.

Packer argued that there is plenty of room for growth in the program, but he said that careful analysis suggests that "for schools that are expanding access to AP among unprepared students, they are probably using resources that could be better used elsewhere." So he said he was not bothered by the book at all. "It feels very similar to the rhetoric I want the College Board to be using," he said.

— Scott Jaschik

http://www.insidehighered.com/news/2011/08/03/new_book_criticizes_colleges_that_go_sat_optional_and_some_high_schools_that_focus_on_ap

Study of Abalone Yields New Insights Into Sexual Reproduction

Abalone live in ocean crevices, shown here at San Diego's Point Loma. (Credit: Eric Hanauer)

ScienceDaily (Aug. 9, 2011) — In new research that could have implications for improving fertilization in humans and other mammals, life scientists studied interactions between individual sperm and eggs in red abalone, an ocean-dwelling snail, and made precise chemical measurements and physical models of these interactions. They are the first scientists to do so.

By simulating the natural habitat of the abalone in the laboratory, the scientists were able to determine the conditions under which sperm-egg encounters and fertilization were most likely to occur.

"If we can understand the basic physics, chemistry and biology of reproduction, then moving from one species to the next is like dotting I's and crossing T's," said the study's lead author, Richard Zimmer, a UCLA distinguished professor of ecology and evolutionary biology.

Red abalone live in ocean crevices and spawn year-round, with females releasing several million eggs and males releasing up to 10 billion sperm directly into the ocean, Zimmer said.

In 2002, Zimmer's research team identified a molecule called tryptophan that is released by female abalone eggs to attract sperm. Now Zimmer and Jeffrey Riffell, an assistant professor of biology at the University of Washington, report that the released tryptophan creates a plume around the egg, greatly enlarging the target area for sperm, in much the same way using a larger tennis racket increases the chances of hitting the ball. The plume increases the egg size by a factor of five, the researchers said.

In addition, the egg has to release very little tryptophan to increase its target area, Zimmer and Riffell report in the journal *Proceedings of the National Academy of Sciences*. The research is currently online and will be in published an upcoming print edition of the journal.

"We established that less than 1 percent of an egg's tryptophan reserves are used by eggs to communicate with sperm," Zimmer said. "The egg does not want to give up tryptophan. The egg sequesters tryptophan and releases just a whiff -- just enough to attract a sperm. It's an effective, evolved trick to enhance the likelihood of an encounter between sperm and egg. There is essentially no cost to the egg for this very effective communication system."

An abalone egg also uses tryptophan for constructing an embryonic nervous system and building neurotransmitters, as well as for other purposes, Zimmer said.

But the success of the egg's plume in attracting sperm, as well as sperm motility and other elements of the fertilization process, are greatly influenced by ocean flow conditions. Therefore, the biologists analyzed the physics of fluid motion in mediating sperm-egg interactions.

"The effect is huge, and was previously unsuspected," said Zimmer, who is a member of UCLA's neuroscience program. "The physics of fluid motion has a profound consequence on the ability of sperm to navigate and find an egg, and therefore on fertilization. We have identified the principal mechanisms by which eggs and sperm communicate and interact within an environment that has fluid motion. The method by which sperm in humans search for and find an egg seems to be the same process as in abalone. Similar fluid dynamics operate whether in the turbulent ocean environment or within a mammalian reproductive tract.

"It appears the forces imposed by fluid motion have acted as selective forces in the evolution of the communication system between sperm and egg within abalone. I expect that we will be able to describe the specific environmental conditions within the human reproductive system that will maximize the likelihood of contact between sperm and egg. The physical and chemical environments are actually quite similar."

Zimmer and Riffell, who was formerly a graduate student in Zimmer's lab, conducted fieldwork at San Diego's Point Loma. They employed tiny sensors in a novel way, using Doppler acoustic technology to measure fluctuations of fluid motion in the environment where abalone naturally reproduce.

The biologists also devised an experimental technique by which they could generate the type of water flow and physical forces found in those habitats in a specialized tank. They used a computer and laser-based imaging system to study and quantify individual interactions between single sperm cells and single eggs, at long distances, away from any walls or boundaries. They are the first scientists to conduct such research.

"We now know properties of fluid motion that relate to the forces imposed at a microscopic scale on individual sperm and individual eggs as they interact," Zimmer said.

As part of the study, Zimmer and Riffell also developed mathematical models that describe the plumes of tryptophan that come off of eggs under a variety of physical conditions.

"We have theoretical models of what the plumes should look like, and images of eggs with sperm swimming around them," Zimmer said. "We mapped the empirical data on top of the theoretically predicted plumes. The question was whether sperm's attraction to eggs could be predicted from our theoretical models of the physics of what the plume looks like. The two mapped onto each other beautifully. The interaction could be predicted."

Because aspects of fluid flow in coastal ocean environments are remarkably similar to those in the human reproductive tract, the research could lead to methods to identify which human donors' sperm are the "most vigorous," with the highest probability of fertilizing an egg, Zimmer said. It may also suggest how to add fluid motion to maximize the probability of sperm fusing with an egg.

The study was funded by the National Science Foundation, the National Institutes of Health, the National Oceanic and Atmospheric Administration, and UCLA's Council on Research.

Scientists have been trying to describe interactions between microorganisms in oceans and chemical plumes for years. Zimmer and Riffell are the first to achieve the chemical measurements and develop the physical models.

Zimmer has received a new three-year federal award from the National Science Foundation for further studies in humans, abalone and sea urchins, working with Riffell and Roman Stocker, an associate professor of in civil and environmental engineering at the Massachusetts Institute of Technology. Stocker is building microscopic devices that will allow the researchers to study a wide variety of chemical and physical environmental conditions.

Zimmer, Riffell and former UCLA postdoctoral scholar Patrick Krug isolated tryptophan and determined its function.

"Sexual reproduction and fertilization are controlled to a significant degree by chemical communication," Zimmer said. "We are learning how chemical communication occurs."

Story Source:
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Journal Reference:

1. R. K. Zimmer, J. A. Riffell. Sperm chemotaxis, fluid shear, and the evolution of sexual reproduction. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1018666108

http://www.sciencedaily.com/releases/2011/08/110804093152.htm

Japan's Tohoku Tsunami Created Icebergs in Antarctica

Before (left) and after (right) photos of the Sulzberger Ice Shelf illustrate the calving event associated with the Japan earthquake and resulting tsunami that occurred on March 11, 2011. The icebergs have just begun to separate in the left image. Credit: European Space Agency/Envisat

ScienceDaily (Aug. 9, 2011) — A NASA scientist and her colleagues were able to observe for the first time the power of an earthquake and tsunami to break off large icebergs a hemisphere away.

Kelly Brunt, a cryosphere specialist at Goddard Space Flight Center, Greenbelt, Md., and colleagues were able to link the calving of icebergs from the Sulzberger Ice Shelf in Antarctica following the Tohoku Tsunami, which originated with an earthquake off the coast of Japan in March 2011. The finding, detailed in a paper published online in the *Journal of Glaciology*, marks the first direct observation of such a connection between tsunamis and icebergs.

The birth of an iceberg can come about in any number of ways. Often, scientists will see the towering, frozen monoliths break into the polar seas and work backwards to figure out the cause.

So when the Tohoku Tsunami was triggered in the Pacific Ocean on March 11 this spring, Brunt and colleagues immediately looked south. All the way south. Using multiple satellite images, Brunt, Emile Okal at Northwestern University and Douglas MacAyeal at University of Chicago were able to observe new icebergs floating off to sea shortly after the sea swell of the tsunami reached Antarctica.

To put the dynamics of this event in perspective: An earthquake off the coast of Japan caused massive waves to explode out from its epicenter. Swells of water swarmed toward an ice shelf in Antarctica, 8,000 miles (13,600 km) away, and about 18 hours after the earthquake occurred, those waves broke off several chunks of ice that together equaled about two times the surface area of Manhattan. According to historical records, this particular piece of ice hadn't budged in at least 46 years before the tsunami came along.

And as all that was happening, scientists were able to watch the Antarctic ice shelves in as close to real-time as satellite imagery allows, and catch a glimpse of a new iceberg floating off into the Ross Sea.

"In the past we've had calving events where we've looked for the source. It's a reverse scenario -- we see a calving and we go looking for a source," Brunt said. "We knew right away this was one of the biggest events in recent history -- we knew there would be enough swell. And this time we had a source."

Scientists first speculated in the 1970s that repeated flexing of an ice shelf -- a floating extension of a glacier or ice sheet that sits on land -- by waves could cause icebergs to break off. Scientific papers in more recent years have used models and tide gauge measurements in an attempt to quantify the impact of sea swell on ice shelf fronts.

The swell was likely only about a foot high (30 cm) when it reached the Sulzberger shelf. But the consistency of the waves created enough stress to cause the calving. This particular stretch of floating ice shelf is about 260 feet (80 meters) thick, from its exposed surface to its submerged base.

When the earthquake happened, Okal immediately honed in on the vulnerable faces of the Antarctic continent. Using knowledge of iceberg calving and what a NOAA model showed of the tsunami's projected path across the unobstructed Pacific and Southern oceans, Okal, Brunt and MacAyeal began looking at what is called the Sulzberger Ice Shelf. The Sulzberger shelf faces Sulzberger Bay and New Zealand.

Through a fortuitous break in heavy cloud cover, Brunt spotted what appeared to be a new iceberg in MODerate Imaging Spectroradiometer (MODIS) data.

"I didn't have strong expectations either way whether we'd be able to see something," Brunt said. "The fastest imagery I could get to was from MODIS Rapid Response, but it was pretty cloudy. So I was more pessimistic that it would be too cloudy and we couldn't see anything. Then, there was literally one image where the clouds cleared, and you could see a calving event."

A closer look with synthetic aperture radar data from the European Space Agency satellite, Envisat, which can penetrate clouds, found images of two moderate-sized icebergs -- with more, smaller bergs in their wake. The largest iceberg was about four by six miles in surface area -- itself about equal to the surface area of one Manhattan. All the ice surface together about equaled two Manhattans. After looking at historical satellite imagery, the group determined the small outcropping of ice had been there since at least 1965, when it was captured by USGS aerial photography.

The proof that seismic activity can cause Antarctic iceberg calving might shed some light on our knowledge of past events, Okal said.

"In September 1868, Chilean naval officers reported an unseasonal presence of large icebergs in the southernmost Pacific Ocean, and it was later speculated that they may have calved during the great Arica earthquake and tsunami a month earlier," Okal said. "We know now that this is a most probable scenario."

MacAyeal said the event is more proof of the interconnectedness of Earth systems.

"This is an example not only of the way in which events are connected across great ranges of oceanic distance, but also how events in one kind of Earth system, i.e., the plate tectonic system, can connect with another kind of seemingly unrelated event: the calving of icebergs from Antarctica's ice sheet," MacAyeal said.

In what could be one of the more lasting observations from this whole event, the bay in front of the Sulzberger shelf was largely lacking sea ice at the time of the tsunami. Sea ice is thought to help dampen swells that might cause this kind of calving. At the time of the Sumatra tsunami in 2004, the potentially

vulnerable Antarctic fronts were buffered by a lot of sea ice, Brunt said, and scientists observed no calving events that they could tie to that tsunami.

"There are theories that sea ice can protect from calving. There was no sea ice in this case," Brunt said. "It's a big chunk of ice that calved because of an earthquake 13,000 kilometers away. I think it's pretty cool."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA/Goddard Space Flight Center.

Journal Reference:

1. Kelly M. Brunt, Emile A. Okal, Douglas R. MacAyeal. Antarctic ice-shelf calving triggered by the Honshu (Japan) earthquake and tsunami, March 2011. *Journal of Glaciology*, 2011; 57 (205): 785-788 [link]

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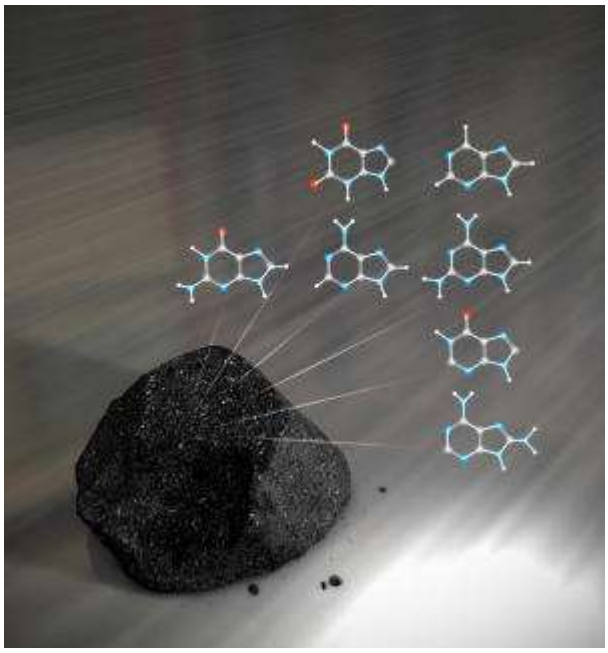
DNA Building Blocks Can Be Made in Space, NASA Evidence Suggests



Meteorites contain a large variety of nucleobases, an essential building block of DNA. (Credit: Artist's concept courtesy of NASA's Goddard Space Flight Center/Chris Smith)

ScienceDaily (Aug. 9, 2011) — NASA-funded researchers have evidence that some building blocks of DNA, the molecule that carries the genetic instructions for life, found in meteorites were likely created in space. The research gives support to the theory that a "kit" of ready-made parts created in space and delivered to Earth by meteorite and comet impacts assisted the origin of life.

"People have been discovering components of DNA in meteorites since the 1960's, but researchers were unsure whether they were really created in space or if instead they came from contamination by terrestrial life," said Dr. Michael Callahan of NASA's Goddard Space Flight Center, Greenbelt, Md. "For the first time, we have three lines of evidence that together give us confidence these DNA building blocks actually were created in space." Callahan is lead author of a paper on the discovery appearing in *Proceedings of the National Academy of Sciences* of the United States of America.

The discovery adds to a growing body of evidence that the chemistry inside asteroids and comets is capable of making building blocks of essential biological molecules. For example, previously, these scientists at the Goddard Astrobiology Analytical Laboratory have found amino acids in samples of comet Wild 2 from NASA's Stardust mission, and in various carbon-rich meteorites. Amino acids are used to make proteins, the workhorse molecules of life, used in everything from structures like hair to enzymes, the catalysts that speed up or regulate chemical reactions.

In the new work, the Goddard team ground up samples of twelve carbon-rich meteorites, nine of which were recovered from Antarctica. They extracted each sample with a solution of formic acid and ran them through a liquid chromatograph, an instrument that separates a mixture of compounds. They further analyzed the samples with a mass spectrometer, which helps determine the chemical structure of compounds.

The team found adenine and guanine, which are components of DNA called nucleobases, as well as hypoxanthine and xanthine. DNA resembles a spiral ladder; adenine and guanine connect with two other

nucleobases to form the rungs of the ladder. They are part of the code that tells the cellular machinery which proteins to make. Hypoxanthine and xanthine are not found in DNA, but are used in other biological processes.

Also, in two of the meteorites, the team discovered for the first time trace amounts of three molecules related to nucleobases: purine, 2,6-diaminopurine, and 6,8-diaminopurine; the latter two almost never used in biology. These compounds have the same core molecule as nucleobases but with a structure added or removed.

It's these nucleobase-related molecules, called nucleobase analogs, which provide the first piece of evidence that the compounds in the meteorites came from space and not terrestrial contamination. "You would not expect to see these nucleobase analogs if contamination from terrestrial life was the source, because they're not used in biology, aside from one report of 2,6-diaminopurine occurring in a virus (cyanophage S-2L)," said Callahan. "However, if asteroids are behaving like chemical 'factories' cranking out prebiotic material, you would expect them to produce many variants of nucleobases, not just the biological ones, due to the wide variety of ingredients and conditions in each asteroid."

The second piece of evidence involved research to further rule out the possibility of terrestrial contamination as a source of these molecules. The team also analyzed an eight-kilogram (21.4-pound) sample of ice from Antarctica, where most of the meteorites in the study were found, with the same methods used on the meteorites. The amounts of the two nucleobases, plus hypoxanthine and xanthine, found in the ice were much lower -- parts per trillion -- than in the meteorites, where they were generally present at several parts per billion. More significantly, none of the nucleobase analogs were detected in the ice sample. One of the meteorites with nucleobase analog molecules fell in Australia, and the team also analyzed a soil sample collected near the fall site. As with the ice sample, the soil sample had none of the nucleobase analog molecules present in the meteorite.

Thirdly, the team found these nucleobases -- both the biological and non-biological ones -- were produced in a completely non-biological reaction. "In the lab, an identical suite of nucleobases and nucleobase analogs were generated in non-biological chemical reactions containing hydrogen cyanide, ammonia, and water. This provides a plausible mechanism for their synthesis in the asteroid parent bodies, and supports the notion that they are extraterrestrial," says Callahan.

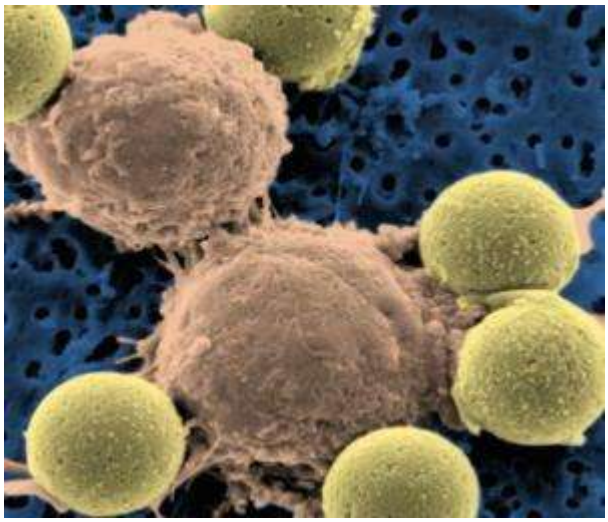
"In fact, there seems to be a 'goldilocks' class of meteorite, the so-called CM2 meteorites, where conditions are just right to make more of these molecules," adds Callahan.

The team includes Callahan and Drs. Jennifer C. Stern, Daniel P. Glavin, and Jason P. Dworkin of NASA Goddard's Astrobiology Analytical Laboratory; Ms. Karen E. Smith and Dr. Christopher H. House of Pennsylvania State University, University Park, Pa.; Dr. H. James Cleaves II of the Carnegie Institution of Washington, Washington, DC; and Dr. Josef Ruzicka of Thermo Fisher Scientific, Somerset, N.J. The research was funded by the NASA Astrobiology Institute, the Goddard Center for Astrobiology, the NASA Astrobiology: Exobiology and Evolutionary Biology Program, and the NASA Postdoctoral Program.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA.

http://www.sciencedaily.com/releases/2011/08/110808220659.htm

Genetically Modified 'Serial Killer' T-Cells Obliterate Tumors in Leukemia Patients



The protocol, which involves removing patients' cells and modifying them in Penn's vaccine production facility, then infusing the new cells back into the patient's body following chemotherapy, provides a tumor-attack roadmap for the treatment of other cancers including those of the lung and ovaries and myeloma and melanoma. (Credit: Image courtesy of University of Pennsylvania School of Medicine)

ScienceDaily (Aug. 10, 2011) — In a cancer treatment breakthrough 20 years in the making, researchers from the University of Pennsylvania's Abramson Cancer Center and Perelman School of Medicine have shown sustained remissions of up to a year among a small group of advanced chronic lymphocytic leukemia (CLL) patients treated with genetically engineered versions of their own T cells. The protocol, which involves removing patients' cells and modifying them in Penn's vaccine production facility, then infusing the new cells back into the patient's body following chemotherapy, provides a tumor-attack roadmap for the treatment of other cancers including those of the lung and ovaries and myeloma and melanoma.

The findings, published simultaneously in the *New England Journal of Medicine* and *Science Translational Medicine* on August 10, are the first demonstration of the use of gene transfer therapy to create "serial killer" T cells aimed at cancerous tumors.

"Within three weeks, the tumors had been blown away, in a way that was much more violent than we ever expected," said senior author Carl June, MD, director of Translational Research and a professor of Pathology and Laboratory Medicine in the Abramson Cancer Center, who led the work. "It worked much better than we thought it would."

The results of the pilot trial of three patients are a stark contrast to existing therapies for CLL. The patients involved in the new study had few other treatment options. The only potential curative therapy would have involved a bone marrow transplant, a procedure which requires a lengthy hospitalization and carries at least a 20 percent mortality risk -- and even then offers only about a 50 percent chance of a cure, at best.

"Most of what I do is treat patients with no other options, with a very, very risky therapy with the intent to cure them," says co-principal investigator David Porter, MD, professor of Medicine and director of Blood and Marrow Transplantation. "This approach has the potential to do the same thing, but in a safer manner."

Secret Ingredients

June thinks there were several "secret ingredients" that made the difference between the lackluster results that have been seen in previous trials with modified T cells and the remarkable responses seen in the current trial. The details of the new cancer immunotherapy are detailed in *Science Translational Medicine*.

After removing the patients' cells, the team reprogrammed them to attack tumor cells by genetically modifying them using a lentivirus vector. The vector encodes an antibody-like protein, called a chimeric antigen receptor (CAR), which is expressed on the surface of the T cells and designed to bind to a protein called CD19.

Once the T cells start expressing the CAR, they focus all of their killing activity on cells that express CD19, which includes CLL tumor cells and normal B cells. All of the other cells in the patient that do not express CD19 are ignored by the modified T cells, which limits side effects typically experienced during standard therapies.

The team engineered a signaling molecule into the part of the CAR that resides inside the cell. When it binds to CD19, initiating the cancer-cell death, it also tells the cell to produce cytokines that trigger other T cells to multiply -- building a bigger and bigger army until all the target cells in the tumor are destroyed.

Serial Killers

"We saw at least a 1000-fold increase in the number of modified T cells in each of the patients. Drugs don't do that," June says. "In addition to an extensive capacity for self-replication, the infused T cells are serial killers. On average, each infused T cell led to the killing of thousands of tumor cells -- and overall, destroyed at least two pounds of tumor in each patient."

The importance of the T cell self-replication is illustrated in the *New England Journal of Medicine* paper, which describes the response of one patient, a 64-year old man. Prior to his T cell treatment, his blood and marrow were replete with tumor cells. For the first two weeks after treatment, nothing seemed to change. Then on day 14, the patient began experiencing chills, nausea, and increasing fever, among other symptoms. Tests during that time showed an enormous increase in the number of T cells in his blood that led to a tumor lysis syndrome, which occurs when a large number of cancer cells die all at once.

By day 28, the patient had recovered from the tumor lysis syndrome -- and his blood and marrow showed no evidence of leukemia.

"This massive killing of tumor is a direct proof of principle of the concept," Porter says.

The Penn team pioneered the use of the HIV-derived vector in a clinical trial in 2003 in which they treated HIV patients with an antisense version of the virus. That trial demonstrated the safety of the lentiviral vector used in the present work.

The cell culture methods used in this trial reawaken T cells that have been suppressed by the leukemia and stimulate the generation of so-called "memory" T cells, which the team hopes will provide ongoing protection against recurrence. Although long-term viability of the treatment is unknown, the doctors have found evidence that months after infusion, the new cells had multiplied and were capable of continuing their seek-and-destroy mission against cancerous cells throughout the patients' bodies.

Moving forward, the team plans to test the same CD19 CAR construct in patients with other types of CD19-positive tumors, including non-Hodgkin's lymphoma and acute lymphocytic leukemia. They also plan to

study the approach in pediatric leukemia patients who have failed standard therapy. Additionally, the team has engineered a CAR vector that binds to mesothelin, a protein expressed on the surface of mesothelioma cancer cells, as well as on ovarian and pancreatic cancer cells.

In addition to June and Porter, co-authors on the NEJM paper include Bruce Levine, Michael Kalos, and Adam Bagg, all from Penn Medicine. Michael Kalos and Bruce Levine are co-first authors on the *Science Translational Medicine* paper. Other co-authors include June, Porter, Sharyn Katz and Adam Bagg from Penn and Stephan Grupp the Children's Hospital of Philadelphia.

The work was supported by the Alliance for Cancer Gene Therapy, a foundation started by Penn graduates, Barbara and Edward Netter, to promote gene therapy research to treat cancer, and the Leukemia & Lymphoma Society.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Pennsylvania School of Medicine.

Journal Reference:

1. M. Kalos, B. L. Levine, D. L. Porter, S. Katz, S. A. Grupp, A. Bagg, C. H. June. T Cells with Chimeric Antigen Receptors Have Potent Antitumor Effects and Can Establish Memory in Patients with Advanced Leukemia. *Science Translational Medicine*, 2011; 3 (95): 95ra73 DOI: 10.1126/scitranslmed.3002842

http://www.sciencedaily.com/releases/2011/08/110810141248.htm

Engineers Reverse E. Coli Metabolism for Quick Production of Fuels, Chemicals

Rice University engineering researchers Ramon Gonzalez (left) and Clementina Dellomonaco reversed one of the most efficient of all metabolic pathways -- the beta oxidation cycle -- to engineer bacteria that make biofuels at a breakneck pace. (Credit: Jeff Fitlow/Rice University)

ScienceDaily (Aug. 10, 2011) — In a biotechnological tour de force, Rice University engineering researchers this week unveiled a new method for rapidly converting simple glucose into biofuels and petrochemical substitutes. In a paper published online in *Nature*, Rice's team described how it reversed one of the most efficient of all metabolic pathways -- the beta oxidation cycle -- to engineer bacteria that produce biofuel at a breakneck pace.

Just how fast are Rice's single-celled chemical factories? On a cell-per-cell basis, the bacteria produced the butanol, a biofuel that can be substituted for gasoline in most engines, about 10 times faster than any previously reported organism.

"That's really not even a fair comparison because the other organisms used an expensive, enriched feedstock, and we used the cheapest thing you can imagine, just glucose and mineral salts," said Ramon Gonzalez, associate professor of chemical and biomolecular engineering at Rice and lead co-author of the *Nature* study.

Gonzalez's laboratory is in a race with hundreds of labs around the world to find green methods for producing chemicals like butanol that have historically come from petroleum.

"We call these 'drop-in' fuels and chemicals, because their structure and properties are very similar, sometimes identical, to petroleum-based products," he said. "That means they can be 'dropped in,' or substituted, for products that are produced today by the petrochemical industry."

Butanol is a relatively short molecule, with a backbone of just four carbon atoms. Molecules with longer carbon chains have been even more troublesome for biotech producers to make, particularly molecules with chains of 10 or more carbon atoms. Gonzalez said that's partly because researchers have focused on ramping up the natural metabolic processes that cells use to build long-chain fatty acids. Gonzalez and students Clementina Dellomonaco, James Clomburg and Elliot Miller took a completely different approach.

"Rather than going with the process nature uses to build fatty acids, we reversed the process that it uses to break them apart," Gonzalez said. "It's definitely unconventional, but it makes sense because the routes nature has selected to build fatty acids are very inefficient compared with the reversal of the route it uses to break them apart."

The beta oxidation process is one of biology's most fundamental, Gonzalez said. Species ranging from single-celled bacteria to human beings use beta oxidation to break down fatty acids and generate energy.

In the *Nature* study, Gonzalez's team reversed the beta oxidation cycle by selectively manipulating about a dozen genes in the bacteria Escherichia coli. They also showed that selective manipulations of particular genes could be used to produce fatty acids of particular lengths, including long-chain molecules like stearic acid and palmitic acid, which have chains of more than a dozen carbon atoms.

"This is not a one-trick pony," Gonzalez said. "We can make many kinds of specialized molecules for many different markets. We can also do this in any organism. Some producers prefer to use industrial organisms other than E. coli, like algae or yeast. That's another advantage of using reverse-beta oxidation, because the pathway is present in almost every organism."

The research was funded by Rice University.

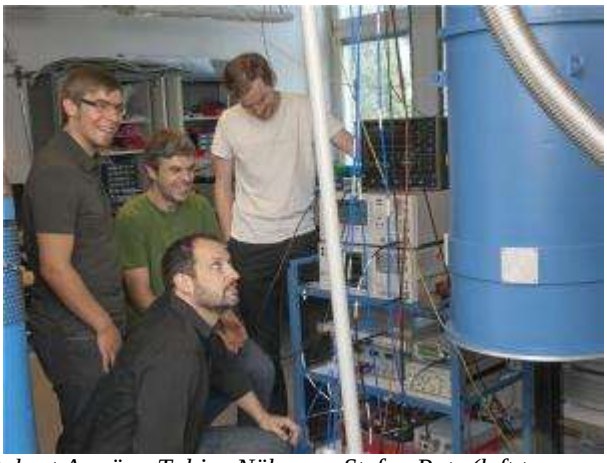
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Rice University, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Clementina Dellomonaco, James M. Clomburg, Elliot N. Miller, Ramon Gonzalez. Engineered reversal of the β-oxidation cycle for the synthesis of fuels and chemicals. *Nature*, 2011; DOI: 10.1038/nature10333

http://www.sciencedaily.com/releases/2011/08/110810133010.htm

Diamond's Quantum Memory



Johannes Majer (bottom) and members of his team: Robert Amsüss, Tobias Nöbauer, Stefan Putz (left to right). (Credit: Image courtesy of Vienna University of Technology, TU Vienna)

ScienceDaily (Aug. 10, 2011) — Two completely different quantum systems were successfully joined at Vienna University of Technology (TU Vienna). This should pave the way to feasible quantum-computer microchips.

For years, quantum computers have been the holy grail of quantum technology. When a normal computer has to solve a number of problems, it can only execute them one after the other. In contrast, a quantum computer could occupy several different states at the same time -- and that way it could try out different possible solutions of a problem at once, finding the correct answer much faster than a normal computer ever could.

Diamonds could now bring physicists one important step closer to the quantum computer. At Vienna University of Technology, microwaves have now been coupled to the quantum states of a diamond. The results of this research project were now published in the scientific journal *Physical Review Letters.*

Different Quantum Technologies in One Chip

For a long time, scientists have been looking for suitable building blocks to construct a quantum computer -- but without much success. Several ideas for systems which can store quantum mechanical information have been put forward, but quantum information is usually very fragile and easily destroyed. A component of a computer has to meet different criteria. It should be able to switch its state very rapidly, and it has to conserve its quantum state for a sufficient amount of time, so that calculations can be carried out. "There is no single quantum system which meets all the requirements," Johannes Majer says. He and his team coupled two completely different kinds of quantum systems, in order to use the advantages of both sides: Microwaves and Diamonds.

Photons and Diamonds

Our usual computers have a processor and a memory. The processor carries out fast calculations, the memory is supposed to remember the results for a long time. The relation between the two different quantum systems unified on one quantum chip at TU Vienna is quite similar: fast manipulations are possible due to a so called microwave resonator. Its quantum state is defined by photons in the microwave regime. This microwave resonator is coupled to a thin layer of diamond, in which quantum states can be stored.

Desirable Flaws

For jewellery, diamonds are supposed to be pure and flawless, but for quantum experiments, the opposite is required. Here, flaws in the diamond are desirable. When nitrogen atoms slip into the regular carbon structure of the diamond, the diamond becomes almost black, but it gains the ability to store quantum states.

"We could show that in our quantum chip, quantum states can actually be transferred between the microwaves and the nitrogen-centers in the diamond," Robert Amsüss (TU Vienna) explains. The more nitrogen atoms take part in this transfer of quantum information, the more stable the diamonds "memory" becomes. Surprisingly, it turned out that also the angular momentum of the atomic nuclei can store quantum information. "This could be the first step towards a nuclear memory device," Johannes Majer suggests.

But first, the diamond quantum chip in its present form should be optimized. All the necessary parts are now there, creating the opportunity for reliable operations.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Vienna University of Technology, TU Vienna.

Journal Reference:

1. R. Amsüss, Ch. Koller, T. Nöbauer, S. Putz, S. Rotter, K. Sandner, S. Schneider, M. Schramböck, G. Steinhauser, H. Ritsch, J. Schmiedmayer, J. Majer. Cavity QED with Magnetically Coupled Collective Spin States. *Physical Review Letters*, 2011; 107 (6) DOI: 10.1103/PhysRevLett.107.060502

http://www.sciencedaily.com/releases/2011/08/110810085459.htm

New Microscope Reveals Nanoscale Details

Magnetic domains appear like the repeating swirls of fingerprint ridges. As the spaces between the domains get smaller, computer engineers can store more data. (Credit: UC San Diego)

ScienceDaily (Aug. 9, 2011) — Physicists at UC San Diego have developed a new kind of X-ray microscope that can penetrate deep within materials like Superman's fabled X-ray vision and see minute details at the scale of a single nanometer, or one billionth of a meter.

But that's not all. What's unusual about this new, nanoscale, X-ray microscope is that the images are not produced by a lens, but by means of a powerful computer program.

The scientists report in a paper published in this week's early online edition of the *Proceedings of the National Academy of Sciences* that this computer program, or algorithm, is able to convert the diffraction patterns produced by the X-rays bouncing off the nanoscale structures into resolvable images.

"The mathematics behind this is somewhat complicated," said Oleg Shpyrko, an assistant professor of physics at UC San Diego who headed the research team. "But what we did is to show that for the first time that we can image magnetic domains with nanometer precision. In other words, we can see magnetic structure at the nanoscale level without using any lenses."

One immediate application of this lens-less X-ray microscope is the development of smaller, data storage devices for computers that can hold more memory.

"This will aid research in hard disk drives where the magnetic bits of data on the surface of the disk are currently only 15 nanometers in size," said Eric Fullerton, a co-author of the paper and director of UC San Diego's Center for Magnetic Recording Research. "This new ability to directly image the bits will be invaluable as we push to store even more data in the future."

The development should be also immediately applicable to other areas of nanoscience and nanotechnology.

"To advance nanoscience and nanotechnology, we have to be able to understand how materials behave at the nanoscale," said Shpyrko. "We want to be able to make materials in a controlled fashion to build magnetic devices for data storage or, in biology or chemistry, to be able to manipulate matter at nanoscale. And in order to do that we have to be able to see at nanoscale. This technique allows you to do that. It allows you to look into materials with X-rays and see details at the nanoscale."

"Because there is no lens in the way, putting a bulky magnet around the sample or adding equipment to change the sample environment in some other way during the measurement is much easier with this method than if we had to use a lens," Shpyrko added.

Ashish Tripathi, a graduate student in Shpyrko's lab, developed the algorithm that served as the X-ray microscope's lens. It worked, in principle, somewhat like the computer program that sharpened the Hubble Space Telescope's initially blurred images, which was caused by a spherical aberration in the telescope's mirror before the telescope was repaired in space. A similar concept is employed by astronomers working in ground-based telescopes who use adaptive optics, movable mirrors controlled by computers, to take out the distortions in their images from the twinkling star light moving through the atmosphere.

But the technique Tripathi developed was entirely new. "There was a lot of simulation involved in the development; it was a lot of work," said Shpyrko.

To test their microscope's ability to penetrate and resolve details at the nanoscale, the physicists made a layered film composed of the elements gadolinium and iron. Such films are now being studied in the information technology industry to develop higher capacity, smaller, and faster computer memory and disk drives.

"Both are magnetic materials and if you combine them in a structure it turns out they spontaneously form nanoscale magnetic domains," Shpyrko. "They actually self assemble into magnetic stripes."

Under the X-ray microscope, the layered gadolinium and iron film looks something like baklava dessert that crinkles up magnetically to form a series of magnetic domains, which appear like the repeating swirls of the ridges in fingerprints. Being able to resolve those domains at the nanoscale for the first time is critically important for computer engineers seeking to cram more data into smaller and smaller hard drives.

As materials are made with smaller and smaller magnetic domains, or thinner and thinner fingerprint patterns, more data can be stored in a smaller space within a material. "The way we're able to do that is to shrink the size of the magnetic bits," Shpyrko said.

The technique should find many other uses outside computer engineering as well.

"By tuning the X-ray energy, we can also use the technique to look at different elements within materials, which is very important in chemistry," he added. "In biology, it can be used to image viruses, cells and different kinds of tissues with a spatial resolution that is better than resolution available using visible light."

The scientists used the Advanced Photon Source, the most brilliant source of coherent X-rays in the Western Hemisphere, at the University of Chicago's Argonne National Laboratory near Chicago to conduct their research project, which was funded by the U.S. Department of Energy. In addition to Tripathi, Shpyrko and Fullerton, a professor of electrical and computer engineering at UC San Diego, other co-authors of the paper include UC San Diego physics graduate students Jyoti Mohanty, Sebastian Dietze and Erik Shipton as well as physicists Ian McNulty and SangSoo Kim at Argonne National Laboratory.

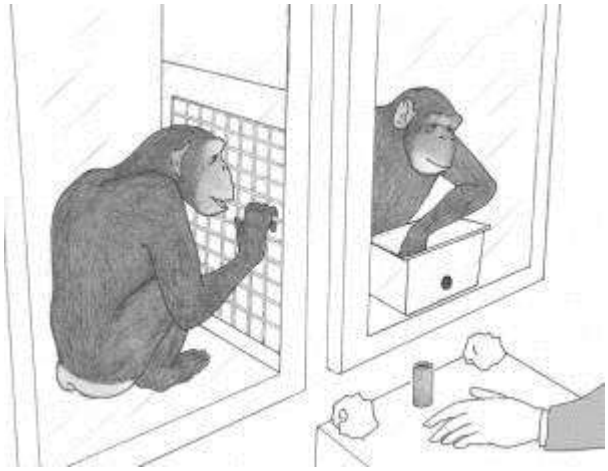
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of California - San Diego. The original article was written by Kim McDonald.

Journal Reference:

1. Ashish Tripathi, Jyoti Mohanty, Sebastian H. Dietze, Oleg G. Shpyrko, Erik Shipton, Eric E. Fullerton, Sang Soo Kim, and Ian McNulty. Dichroic coherent diffractive imaging. *Proceedings of the National Academy of Sciences*, August 8, 2011 DOI: 10.1073/pnas.1104304108

http://www.sciencedaily.com/releases/2011/08/110808154130.htm

Chimpanzees Are Spontaneously Generous After All, Study Shows



A new study challenges previous findings that humans are an altruistic anomaly, and positions chimpanzees as cooperative, especially when their partners are patient. In each trial, the chooser, which was always tested with her partner in sight, selected between differently colored tokens from a bin. One colored token could be exchanged with an experimenter for treats for both members of the pair (prosocial); the other colored token would result in a treat only for the chooser (selfish). (Credit: Image courtesy of Emory University; from Victoria Horner, J. Devyn Carter, Malini Suchak, Frans B. M. de Waal. Spontaneous prosocial choice by chimpanzees. Proceedings of the National Academy of Sciences, 2011)

ScienceDaily (Aug. 9, 2011) — Researchers at the Yerkes National Primate Research Center have shown chimpanzees have a significant bias for prosocial behavior. This, the study authors report, is in contrast to previous studies that positioned chimpanzees as reluctant altruists and led to the widely held belief that human altruism evolved in the last six million years only after humans split from apes.

The current study findings are available in the online edition of *Proceedings of the National Academy of Sciences*.

According to Yerkes researchers Victoria Horner, PhD, Frans de Waal, PhD, and their colleagues, chimpanzees may not have shown prosocial behaviors in other studies because of design issues, such as the complexity of the apparatus used to deliver rewards and the distance between the animals.

"I have always been skeptical of the previous negative findings and their over-interpretation, says Dr. de Waal. "This study confirms the prosocial nature of chimpanzees with a different test, better adapted to the species," he continues.

In the current study, Dr. Horner and colleagues greatly simplified the test, which focused on offering seven adult female chimpanzees a choice between two similar actions: one that rewards both the "actor," the term used in the paper for the lead study participant, and a partner, and another that rewards only the actor/chooser herself. Examples of the critically important simplified design aspects include allowing the study partners to sit close together and ensuring conspicuous food consumption, which the researchers achieved by wrapping pieces of banana in paper that made a loud noise upon removal.

In each trial, the chooser, which was always tested with her partner in sight, selected between differently colored tokens from a bin. One colored token could be exchanged with an experimenter for treats for both members of the pair (prosocial); the other colored token would result in a treat only for the chooser (selfish). All seven chimpanzees showed an overwhelming preference for the prosocial choice. The study also showed

the choosers behaved altruistically especially towards partners who either patiently waited or gently reminded them that they were there by drawing attention to themselves. The chimpanzees making the choices were less likely to reward partners who made a fuss, begged persistently or spat water at them, thus showing their altruism was spontaneous and not subject to intimidation.

"We were excited to find female after female chose the option that gave both her and her partner food," says Dr. Horner. "It was also interesting to me that being overly persistent did not go down well with the choosers. It was far more productive for partners to be calm and remind the choosers they were there from time to time," she continues.

The authors say this study puts to rest a longstanding puzzle surrounding chimpanzee altruism. It is well-known these apes help each other in the wild and show various forms of empathy, such as reassurance of distressed parties. The negative findings of previous studies did not fit this image. These results, however, confirm chimpanzee altruism in a well-controlled experiment, suggesting human altruism is less of an anomaly than previously thought.

The study authors next plan to determine whether the altruistic tendency of the chimpanzees towards their partners is related to social interactions within the group, such as reciprocal exchanges of food or social support.

For eight decades, the Yerkes National Primate Research Center, Emory University, has been dedicated to conducting essential basic science and translational research to advance scientific understanding and to improve the health and well-being of humans and nonhuman primates. Today, the center, as one of only eight National Institutes of Health-funded national primate research centers, provides leadership, training and resources to foster scientific creativity, collaboration and discoveries. Yerkes-based research is grounded in scientific integrity, expert knowledge, respect for colleagues, an open exchange of ideas and compassionate quality animal care.

Within the fields of microbiology and immunology, neurologic diseases, neuropharmacology, behavioral, cognitive and developmental neuroscience, and psychiatric disorders, the center's research programs are seeking ways to: develop vaccines for infectious and noninfectious diseases; treat drug addiction; interpret brain activity through imaging; increase understanding of progressive illnesses such as Alzheimer's and Parkinson's diseases; unlock the secrets of memory; determine how the interaction between genetics and society shape who we are; and advance knowledge about the evolutionary links between biology and behavior.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Yerkes National Primate Research Center, Emory University.

Journal Reference:

1. Victoria Horner, J. Devyn Carter, Malini Suchak, Frans B. M. de Waal. Spontaneous prosocial choice by chimpanzees. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1111088108

http://www.sciencedaily.com/releases/2011/08/110808152220.htm

The Thrill of Boredom

By PETER TOOHEY

Peter Toohey is a professor of Greek and Roman studies at the University of Calgary, and the author of "Boredom: A Lively History."

Romeo Gacad/Agence France-Press — Getty Images

Calgary, Alberta

SANTINO, a 33-year-old chimp, likes to collect rocks before the Furuvik Zoo in Sweden opens and pile them up on the visitor side of his island. He greets the 300 less hirsute primates who crowd around his enclosure every day with missiles hurled from his cache. Indignation? Bad temper? Or is Santino so bored with his captivity that he's taken to seeking relief — and entertainment — by throwing rocks at those on the outside?

Boredom, as I like to think Santino illustrates, is a pretty straightforward emotion. It's a product of predictability and of unavoidable and unchanging circumstances. And if there's no break from the boredom, it can easily spill over into anger and even violence. There's a message here: avoid situations that may produce boredom, or rocks are liable to fly.

Simple boredom has a very long history. It's not, as many argue, just a modern malaise. In fact, it's a universal emotion that was just as evident in antiquity as it is in animals. My favorite example from

boredom's long and colorful past is a Latin inscription from the Italian city of Benevento, in a region now better known for the Camorra than for boredom. The inscription dates from the third century of our era:

For Tanonius Marcellinus, a most distinguished man of the consular rank at Campania and a most worthy patron as well, because of the good deeds by which he rescued the population from endless boredom, the entire people judges that this inscription should be recorded.

That must have been quite some boredom to warrant such a dedication. It may be unique in Western history. Tanonius Marcellinus probably cured the Beneventans' boredom, which may have spilled over into rioting and rock-throwing, with the still efficacious regimen of aerobic exercise — in this case a gladiatorial contest in an amphitheater.

These days it often seems that it's young people who complain most about boredom. Why so? Do the many means of stimulation in this age of instant entertainment make it much harder for them to keep interested and absorbed? Perhaps. But if the Beneventans are anything to go by, that's probably not the only reason. Their boredom is more likely to result from the collision of their exuberant young lives with an adult insistence that they buckle down, not always reasonably, to the demands of the grown-up world.

So, if you see a young person assuaging a case of boredom with graffiti, don't blame the age of the Xbox. The motive may be the same as that of the Roman graffitist who wrote 2,000 years ago, "Wall, I wonder that you haven't fallen down in ruin, when you have to support all the boredom of your inscribers." Graffiti is often a product of the idle vandalism of youths suffering a boredom not unlike that of their ancient predecessors.

Maybe this link with the very young is why boredom often produces such unsympathetic and incredulous responses in adults — and why its beneficial possibilities are so often missed. Who would wish to share such an emotion with a mere child? Instead, grown-ups will sometimes complain that they suffer not from simple boredom, but from an existential boredom.

This form of "spiritual" boredom is a very serious matter indeed. It was once quite fashionable, and it still exudes an exotic world-weariness — much more impressive than to simply say, "I'm bored." Existential boredom, it is claimed, can infect a person's very existence with unrelieved emptiness, isolation and alienation. And it takes in many well-known conditions, evoked by such names as melancholia, ennui, mal de vivre, tristesse, taedium vitae, acedia, spiritual despair, existentialist "nausea" — and garden-variety depression. It's the subject of most of the very solemn and earnest books written on boredom.

But not of David Foster Wallace's posthumously published novel, "The Pale King." This book puts simple boredom — the boredom of tax returns, offices and tax examinations — on center stage. It's also the sort of boredom that some of Wallace's tortuously long and deliberately difficult descriptions invoke in his reader. For this is not simply a dystopian version of modern life from which the young I.R.S. wigglers yearn to escape. Rather, the routines of the tax office seem to provide for them — almost all of whom are troubled individuals with difficult backgrounds — an orderly, unvarying, dependable home. Santino would not have lasted long at the Internal Revenue Service. But Wallace showed how boredom can illuminate and soothe the more extreme emotional states.

It's not just in "The Pale King" that boredom extends — as unlikely as it sounds — the helping hand. In real life it acts as an early warning that certain situations may be dangerous to human well-being. It's not unlike disgust, another emotion that helps humans prosper. Just as disgust stops you from eating what is noxious, so boredom, in social settings, alerts you to situations that can do no psychological good. Boredom, interpreted properly, might act as an alarm. It urges you to step back.

So perhaps boredom is designed to encourage people to adapt their behavior and to protect them from social toxins, just as its first cousin disgust is designed, biologically speaking, to cause people to adapt their behavior to real physical toxins. Perhaps boredom should be viewed just as gout sometimes is, or angina or even mild strokes — as a sign of worse things to follow unless there's a change in lifestyle. It's not for nothing that the great Russian novelist Ivan Goncharov's beguiling behemoth of boredom, the endearing Ilya Oblomov, perished of a stroke after a long lifetime of ignoring boredom's siren signals. Boredom, I am saying, may play a salutary, evolutionary role in human life.

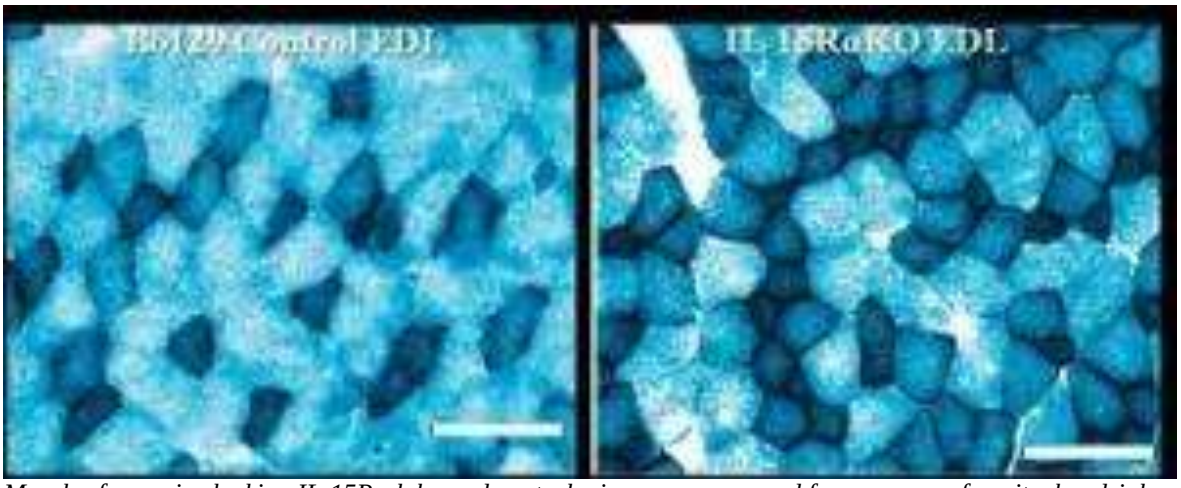
And boredom has other, less spectacular, benefits. The airman Dunbar in Joseph Heller's "Catch-22" thought it was good for longevity — by slowing the passage of time. Boredom can also encourage innovation. It can breed dissatisfaction with ways that are intellectually shopworn. It can drive the thoughtful to question the accepted and to seek out beneficial change. And daydreaming — it's often a byproduct of boredom. In their book, "The Secret World of Doing Nothing," two Swedish social scientists, Billy Ehn and Orvar Lofgren, wonder if it makes people "able to imagine new possibilities." Chris Fogle, the I.R.S. functionary in "The Pale King," thinks so. "I tend," he explains, "to do my most important thinking in incidental, accidental, almost daydreamy ways."

Boredom makes our lives run more smoothly and even more happily. That's if we heed its warning and try to remedy the deleterious constraints of a Santino-like existence.

Boredom should not be abused, exploited, ignored, sneered at, rejected or talked down to as a product of laziness or of an idle, uninventive and boring mind. It's there to help, and its advice should be welcomed and acted upon. That many of us suffer from it should be no cause for embarrassment. Boredom deserves respect for the beneficial experience that it is.

http://www.nytimes.com/2011/08/07/opinion/sunday/the-thrill-of-boredom.html

Genetic Basis for Muscle Endurance Discovered in Animal Study



Muscles from mice lacking IL-15R-alpha and control mice were processed for presence of a mitochondrial marker. The mice lacking IL-15R-alpha show a greater number of darkly stained muscle fibers (right), indicating an increase in their mitochondrial content caused by reprogramming due to the lack of IL-15R-alpha. (Credit: Emidio E. Pistilli, PhD, & Tejvir S. Khurana, MD, PhD, Perelman School of Medicine, University of Pennsylvania. Image is based on a Figure from Pistilli et al. 2011. Journal of Clinical Investigation.)

ScienceDaily (Aug. 9, 2011) — Researchers at the Perelman School of Medicine at the University of Pennsylvania have identified a gene for endurance, or more precisely, a negative regulator of it. Not having the gene relates to greater endurance in the knockout mice that were studied. The investigators also showed that the gene is linked to Olympic-level athletes in endurance sports such as swimming compared to athletes in sprint sports such as the 100-meter dash.

The study appears online this week in the *Journal of Clinical Investigation*. The work has implications for improving muscle performance in disease states including metabolic disorders, obesity, and aging.

"We have shown that mice lacking the gene run six times longer than control mice and that the fatigable muscles of the mouse -- the fast muscle in the front of the leg -- have been reprogrammed and are now fatigue-resistant," explains senior author Tejvir S. Khurana, MD, PhD, professor of Physiology and member of the Pennsylvania Muscle Institute. "This has wide ramifications for various aspects of muscle biology ranging from athletics to treating muscle and metabolic diseases."

The gene codes for a protein called Interleukin-15 receptor-alpha (IL-15R-alpha), which acts alone or in conjunction with the IL-15 protein. IL-15R-alpha is important in the immune response, but it also has other functions. IL-15 and IL-15R-alpha have been implicated in muscle physiology, but the exact role in muscle function has not been defined.

"We found a previously unrecognized role for IL-15R-alpha in defining muscle function, and manipulation of this gene has the potential to improve muscle performance in disease states including metabolic disorders, obesity, and aging." says lead author Emidio E. Pistilli, PhD, who was a postdoctoral researcher at Penn and is now an assistant professor in the Division of Exercise Physiology at the West Virginia School of Medicine.

Slow Vs. Fast

Slow muscles are used for endurance and fast muscles are used for speed. The champion fast muscles are the muscles moving the eye, but they are also fatigue-resistant, the only muscles like this.

In the IL-15R-alpha knockout mouse used in this study, fast muscles behave like slow muscles. These mice ran 6.3 times greater distances and had greater ambulatory activity than controls. Their fast muscles displayed fatigue-resistance and slower contractions compared to fast muscles in control mice.

They also showed that the loss of IL-15R-alpha induces a shift in how energy is burned in fast muscles, substantially increasing fatigue resistance and exercise capacity.

The molecular signature of the muscles in the knockout mice included a greater number of active transcription factors, which indicates more muscle fibers with more mitochondria, and the machinery to better process calcium since this chemical drives muscle contraction. Mitochondria are the energy storehouses of the cell.

Morphologically, the fast muscles had a greater number of muscle fibers, smaller fiber areas, and a greater number of nuclei per fiber. The alterations of physiological properties and increased resistance to fatigue in the fast muscles are consistent with a shift towards a slower, more oxidative muscle type in the knockout mice.

The study also found significant associations between the gene and elite endurance athletes and hence supports the possibility that these athletes had a genetic predisposition or advantage.

From these two lines of evidence, the researchers concluded that IL-15R-alpha plays a role in defining the function of fast skeletal muscles.

Importantly, the study demonstrates that muscles can be reprogrammed to perform much better at endurance sports and hence IL-15R-alpha manipulation is of great importance from an athletic doping standpoint as currently it is neither tested for nor do methods exist to detect its misuse by athletes. The investigators are working toward this.

This research identifies a "druggable target" that allows possible reprogramming of muscle function by increasing genes, proteins and pathways typically expressed in slow or fatigue-resistant muscle, similar to adaptations seen after endurance exercise. It is widely accepted that these types of adaptations would be beneficial or protect against obesity, diabetes and aging and may help ameliorate pathology in myopathies such as muscular dystrophy. Hence, say the researchers, the identification of this pathway should facilitate better understanding of these diseases and aid in the development of rational therapies drugs for these disorders.

From a translational research point of view the team will test the role IL-15R-alpha plays in obesity, diabetes, aging, and muscle diseases, as well as develop methods to harness the therapeutic potential of it for patients.

The research was funded by the National Institute of Arthritis and Musculoskelatal and Skin Diseases; the National Eye Institute; the National Institute on Aging; and the VA Puget Sound Health Care System.

In addition to Khurana and Pistilli, co-authors were from the Institute for Neuroscience and Muscle Research, The Children's Hospital at Westmead, Sydney, New South Wales, Australia; the Australian Institute of Sport, Canberra, Australia; Geriatric Research, Education, and Clinical Center, VA Puget Sound Health Care System, Seattle; Division of Gerontology and Geriatric Medicine, Department of Medicine, University of Washington, Seattle; and the Division of Endocrinology, Diabetes, and Metabolism, Penn.

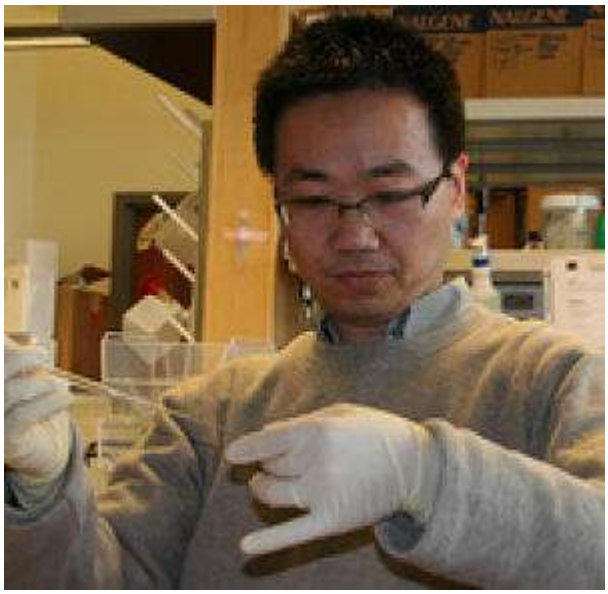
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Pennsylvania School of Medicine.

Journal Reference:

1. Emidio E. Pistilli, Sasha Bogdanovich, Fleur Garton, Nan Yang, Jason P. Gulbin, Jennifer D. Conner, Barbara G. Anderson, LeBris S. Quinn, Kathryn North, Rexford S. Ahima, Tejvir S. Khurana. Loss of IL-15 receptor α alters the endurance, fatigability, and metabolic characteristics of mouse fast skeletal muscles. *Journal of Clinical Investigation*, 2011; 121 (8): 3120 DOI: 10.1172/JCI44945

http://www.sciencedaily.com/releases/2011/07/110718121555.htm

Scientist Develops Virus That Targets HIV: Using a Virus to Kill a Virus



USC chemical engineering professor, Pin Wang. (Credit: Image courtesy of University of Southern California)

ScienceDaily (Aug. 9, 2011) — In what represents an important step toward curing HIV, a USC scientist has created a virus that hunts down HIV-infected cells.

Dr. Pin Wang's lentiviral vector latches onto HIV-infected cells, flagging them with what is called "suicide gene therapy" -- allowing drugs to later target and destroy them.

"If you deplete all of the HIV-infected cells, you can at least partially solve the problem," said Wang, chemical engineering professor with the USC Viterbi School of Engineering.

The process is analogous to the military practice of "buddy lasing" -- that is, having a soldier on the ground illuminate a target with a laser to guide a precision bombing strike from an aircraft.

Like a precision bombing raid, the lentiviral vector approach to targeting HIV has the advantage of avoiding collateral damage, keeping cells that are not infected by HIV out of harm's way. Such accuracy has not been achieved by using drugs alone, Wang said.

So far, the lentiviral vector has only been tested in culture dishes and has resulted in the destruction of about 35 percent of existing HIV cells. While that may not sound like a large percentage, if this treatment were to be used in humans, it would likely be repeated several times to maximize effectiveness.

Among the next steps will be to test the procedure in mice. While this is an important breakthrough, it is not yet a cure, Wang said.

"This is an early stage of research, but certainly it is one of the options in that direction," he said.

Wang's research, which was funded by the National Institutes of Health, appears in the July 23 issue of *Virus Research*.

story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Southern California. The original article was written by Robert Perkins.

Journal Reference:

1. Chi-Lin Lee, Jason Dang, Kye-Il Joo, Pin Wang. Engineered lentiviral vectors pseudotyped with a CD4 receptor and a fusogenic protein can target cells expressing HIV-1 envelope proteins. *Virus Research*, 2011; DOI: 10.1016/j.virusres.2011.07.010

http://www.sciencedaily.com/releases/2011/08/110808154132.htm

In Auto Test in Europe, Meter Ticks Off Miles, and Fee to Driver

By ELISABETH ROSENTHAL

Michel deGroot for The New York Times

The Netherlands used meters in a trial of a controversial government tax proposal to charge drivers a fee for the miles they drive.

EINDHOVEN, the Netherlands — As Sander Van Dedem recalled watching the charges tick up every 10 seconds on the dashboard meter on the way to the airport, he resolved to try public transportation next time. "Looking at the money makes you realize that a car isn't always a good idea," said Mr. Van Dedem, a commercial sales manager for I.B.M. here.

But his pricey ride was not in a taxi. He was driving his own Volvo XC60.

The car had been outfitted with the meter so that Mr. Van Dedem could take part in a trial of a controversial government tax proposal to charge drivers a fee for the miles they drive. The meter also factors in the cost to society in the form of pollution, traffic congestion, greenhouse gas emissions and wear and tear on roads.

Hooked up to the Internet wirelessly and to GPS, the system tabulates a charge for each car trip by using a mileage-based formula that also takes account of a car's fuel efficiency, the time of day and the route. (Driving on busier thoroughfares costs more than driving on less-traveled roads.) At the end of each month, the vehicle's owner would receive a bill detailing times and costs of usage, not unlike a cellphone bill, although participants in the trial did not have to pay the charges.

Governments in car-clogged regions of Europe, Asia and even the United States have shown an eagerness to explore such systems, but they face a nagging challenge in placing them in private vehicles. Even in environmentally conscious places like the Netherlands, voters and politicians often vehemently oppose the

programs, citing privacy concerns about the monitoring of drivers' whereabouts and the introduction of what amounts to a new type of tax.

In the Netherlands, where by some accounts residents have the highest average commuting time in Europe and a reputation for receptivity to environmental innovation, the government had planned to institute a nationwide system next year. But the plan was shelved when a new government came to power in 2010.

"The winning party said, 'If you elect us, there won't be new taxes,' and killed the plan," said Ab Oosting, a city official in Eindhoven.

Supporters of the meters contend that the charges are more equitable than current taxes like automobile purchase and registration fees, because they derive from actual use rather than mere ownership. If imposed, they could supplant gas and vehicle taxes as well as tolls. Governments could program computers to require consistent gas guzzlers to pay higher rates, for example.

Distance charging also provides a means of replacing declining revenues from gasoline taxes as more people drive highly efficient, hybrid or electric cars, helping governments that have traditionally depended on gas taxes for road upkeep.

Equally important, studies have found that the meters provide instantaneous negative feedback, the kind that psychologists say changes behavior.

"At the beginning you're looking at it all the time and thinking of costs, and pretty quickly it starts to influence what you do," said Mr. Van Dedem, whose rush-hour airport ride would have incurred a charge of just over $5 under the rates proposed in the Netherlands.

The effect has been lasting: even though the trial was two years ago and the meter has been removed, he now works from home more in the mornings and walks to the market, he said.

In Europe, countries like Germany and Denmark "were looking to the Netherlands to test the technology" and were disappointed when the plan was shelved, said Peder Jensen, a transportation expert at the European Environment Agency. Germany has already started using a GPS-based charging system for trucks, and France is planning to do so, a step that is less politically volatile than charging drivers of private cars.

In the United States, states including Oregon, Texas and Minnesota have explored mileage charging systems, but the first tentative proposals have faced obstacles there as well. A longstanding proposal in Oregon to introduce such charging for electric cars stalled in committee this spring and never made it to a vote. It suggested a transitional rate of 0.85 cents per mile in 2015 and 1.85 cents per mile by 2018.

Although the program was primarily an attempt to recoup lost revenue from gasoline taxes, it was also intended to test the waters for distance charging that would eventually apply to all cars.

"We started with a new type of car where the policy argument was clear: electric vehicles don't pay gas taxes," said James M. Whitty, manager of Oregon's Office of Innovative Partnerships and Alternative Funding. "But the idea was to get by the anxiety about what the new tax system was about, to see if it would be acceptable."

The Oregon proposal did not envisage installing real-time GPS-based meters in each car, but merely recording the mileage though the odometer. An earlier trial using a GPS unit had stirred a public outcry even though the unit did not reveal locations as it relayed data to the state. "The public didn't trust that," Mr. Whitty said.

Eric-Mark Huitema, a transportation specialist with I.B.M., which developed the system used in the Netherlands in collaboration with the semiconductor company NXP, said that the hardware and software performed well in the testing period.

"The trials work well, but it's first a psychological issue and second a political choice," he said. "To do it you need support of the government, and it needs to happen when there is not an election because there's always a bit of resistance."

Under the shelved plan in the Netherlands, rates would have varied from 4.5 to 45 cents per mile. Government studies predicted that 60 or 70 percent of drivers would pay less than under the current system of car taxation.

The European Union continues to prod member states to try distance charging despite the setbacks. High car and gas taxes have failed to stem the growth of car use in Western Europe, leaving densely populated countries paralyzed at rush hour.

Belgium plans to start a small trial of 50 drivers in September. "Traffic jams are expected to double by 2020; the roads are full, full, full," said Freidl Maertens, director of the pilot program in Leuven, Belgium. Singapore is also contemplating a mileage-based tax system, though so far the plans do not include a digital display, which some experts see as a crucial component.

According to data collected in the Eindhoven trial, watching the small charges add up changed driving habits.

"Seeing the meter helps," Mr. Huitema said. "The old taxes don't do that — you fill the tank, pay and try not to worry anymore."

http://www.nytimes.com/2011/08/11/science/earth/11meter.html?ref=science

Humankind's Ascent Took Path of Yeast Resistance

There's a strong case to be made that the first species cultivated by humankind was brewer's yeast, and a generation of researchers will drink to that.

By Rob Dunn

Saccharomyces cerevisiaea (yeast) on the left, beer on the right. Scientists make the case that the first species cultivated by humankind was brewer's yeast — leading to alcoholic beverages of all kinds. (Wikipedia, Thinkstock)

Once upon a time there were no farms. People ate fruit off the vine and killed animals as they ran. They roasted things when it suited them but just as often ate them raw. The world was like this for thousands of years, a place of arrows and nuts where everything that was necessary could be found. One might imagine many reasons for giving up on those old, superficially idyllic, ways. Perhaps it was hunger, that ultimate mother of invention, or maybe it was just invention itself, unmotivated by need.

But these are not the only options. Solomon H. Katz at the University of Pennsylvania thinks it was beer.

Yes, beer. Katz's argument is that once beer was invented, people would have liked it and wanted more of it, more than could be made out of gathered seeds.

Imagine the scenario: An early Egyptian left wild wheat or some other grass seed in water. Maybe he had intended to make gruel, but he left it too long and the slurry sprouted (and happened to have fermented, as

well). Yet, because he was hungry or thirsty or simply dissatisfied, he drank it anyway. When he did, voilà! With that (little) buzz was born the germ of the need for agriculture.

Or at least this is part of Katz's idea. He also thinks that beer is, or at least was, good for us. Beer, he has suggested, is healthy when compared to the raw products out of which it is typically made.

Relative to raw wheat or barley, for example, beer is enriched in some fats, vitamin B and the amino acid lysine. Relative to the water likely to have been found in early human settlements, the first beer is also likely to have been less ridden with pathogens. Fermentation purifies. It may be a stretch to say that beer does the body good, but relative to our early alternatives, it probably did the body better (as by some measures it continues to do today).

Katz's beer hypothesis was debated actively in the late 1980s in scientific papers and Pennsylvania bars. It led to attempts to recreate the first beers (e.g., Anchor Steam's Sumerian brews or Dogfish Head's ancient ales) from what has turned out to be the oldest discovered recipe. It also fueled the scientific careers of young, excitable scientists and helped usher in a new wave of research at the University of Pennsylvania — think of this as an Indiana Jones of ancient potables — on the history of food and booze.

But with time, Katz's idea lost some of its shine. It was not proven wrong so much as proven difficult to prove. Anthropology is full of such ripe but hard-to-reach fruits.

When Katz (now, a bit ironically, director of the Krogman Center for Childhood Growth and Development) first offered his hypothesis, the evidence he brought to bear was the standard stuff of anthropology — potsherds, ancient writing and burials mixed with a pinch of raw insight. But times have changed a great deal since the 1980s. Modern genetics now allows scientists to see the invisible genes lurking in all things living and dead, including beer, and with them, more of the hidden story.

What Katz knew but tended to ignore when he first considered the story of beer was that it was not the only fermented drink important to the human story.

Fermented drinks and foods, from beer to sake, bread to wine, are consumed in West Africa, China, Japan and have, almost certainly, been consumed in one form or another since before the first seed was sewn (some monkeys are even known to seek out fermented fruits and suffer the stumbling consequences). The eminent anthropologist Claude Lévi-Strauss regarded the invention of alcohol — though perhaps discovery is the better word — as a marker of the passage of peoples from "nature to culture." Fermented alcoholic drinks have been documented from settlements more than 7,000 years old in China, 5,000 years ago in Mesopotamia and only slightly later in Egypt. In each place where alcohol has been made, it has been regarded in one way or another as special food both for the Pharaohs or kings and the afterlife. Even Noah, who had space for just two of each animal on the ark, made sure to leave some room for beer.

In the last three years, scientists have begun to revisit the links between civilization and beer, and between civilization and wine, sake, other fermented drinks and foods more generally. Before I tell you the conclusion to the new story, it is useful to know the characters. Fortunately, there's really only one.

A single species, *Saccharomyces cerevisiaea*, sometimes called brewer's yeast, is responsible for nearly all fermented drinks, everywhere. This yeast-of-all-trades is found in the wild on tree trunks and fruits, though unpredictably and only here and there. Yet, from its rare germ grows a great feast. While the cow may give us milk and dogs give us protection and companionship, it is *Saccharomyces cerevisiaea* alone that gives us beer, wine, rice wine, fermented milk (not my favorite, either), sake, bread and much more.

In doing so, it might reasonably be in the running for the real title of "man's best friend." Yeast has the near miraculous ability to turn raw foods into delicacies. It does so by growing until, in each bite of bread or sip of wine, we savor the flavor of its body on our lips and feel it in our blood and head.

Brewer's yeast is easy enough to cultivate. It grows on sugar, although "grows" is not really quite the right word. More accurately, it divides. One shimmering, blue-brown cell becomes two, two become four, and four — eventually — become billions. Brewer's yeast prefers to live where it has oxygen, but it can also grow when and where there is little or even no oxygen. When humans make beer or wine, yeast is usually allowed to divide for hours or days until it is abundant. Then the conditions of the fermentation are changed to make it begin to live without oxygen, and as a consequence to produce ethanol — aka alcohol — and carbon dioxide as waste. For such waste we are grateful.

But how did a single species of yeast come to be used to produce so much in so many cultures? And, to return to Katz, did these events precipitate the need for agriculture?

In one version of the story, we might imagine that yeast is simply in the air, a kind of living ether that, when necessary, appears. The other version, equally if not more improbable, is that yeast has evolved with us, as a crop, much like wheat, corn or cows. If yeast has evolved with agriculture and our spread, its genes might also be able to tell part of our story as a kind of "bioglyph" rewritten with each act of yeast sex, division or mutational change.

The answer, or at least a big clue, was revealed when scientists decided to construct an evolutionary tree for yeast based on the genes of yeasts found in different foods. When they did, they were in for a surprise. The yeasts in beer, wine, sake and other fermented drinks and foods were different, *very* different, from each other. Those differences were ancient. Yeast does not just colonize any old food out of the hovering ether. It evolved and diversified as civilization and agriculture have evolved and diversified. Out of a few or even just one ancestral yeast strain, many new varieties have emerged. Just as from wolves came big dogs, small dogs, furry dogs and bald dogs, from one or a few yeast strains came all of the alcoholic flavors that we hold so dear.

Functionally, many of the differences among varieties of yeasts reflect their different lifestyles and roles. The yeast in ale beers is specially suited for the ways in which such beers are gardened. Because brewers tended to scoop yeast off of the top of beer (to later put in their next batch of beer), yeasts that ale brewers use tend to rise up out of the liquid they are in. They do this by clumping onto the carbon dioxide they produce, in order to catch a ride. In the wild, floating up and out of your food would be bad, but in beer it is vital to having your genes passed on. Malt beer yeasts also float, but they have extra copies of the genes associated with breaking down maltose, the main source of carbon in malt.

Similar (but different) stories emerge for wine. Many wine strains have evolved the ability to cope with high levels of sulfite, which has been used to clean wine containers since the Middle Ages. These sulfite-resistant yeasts have succeeded because they can pass from one batch of wine to the next without depending on a human to introduce them.

Bread yeasts, on the other hand, tend to be aggressive. They divide quickly, because we have tended to favor those bread yeasts that carbonate dough in the shortest amount of time possible. This fast action produces more odd flavors and so they have been (unconsciously) avoided in wines and beers. Bread yeasts have also lost the ability present in beer yeasts, and especially present in wine yeasts, to tolerate high alcohol concentrations. Put bread yeasts in with your grapes and they will die before they have produced much alcohol.

The new evolutionary tree tells us more than what the changes have been. It also begins to provide hints as to where and when those changes happened. Nearly all lineages of wine yeasts are related. They appear to have

diverged early and, for example, all champagne yeasts appear most closely related to other champagne yeasts. Show me yeast, and I could probably tell you its region and wine variety. Sake yeasts share another old lineage, as are the yeasts associated with rice wine in China, fermented milk in Morocco, palm wine in West Africa or rum. Each of these lineages is the story of a drink, but also of a people and the accumulation of moments around campfires or on back porches sipping and discussing life.

Not all stories revealed by yeast genes are so simple. Bread yeasts appear to be different in different regions and have had different histories, a finding in line with the relatively late appearance of bread in archaeological sites. Sicilian bread yeast descended from wine yeasts. Other bread yeasts have other ancestors. These differences yield differences in tastes. Perhaps part of that un-capturable essence of Sicilian bread, for example, is a hint of ancient Merlot.

Then there is the story of lager beers and their yeasts, which evolved when Bavarians outlawed the summer brewing of beer. Winter brewing favored new hybrid yeasts able to live in the cold. These yeasts continue to give lager beers some of their unique flavors and are what made lagers possible in the first place.

Lagers exist because yeast was, relatively quickly, able to evolve, and evolution did not stop. Since that Bavarian law was originally passed, lager yeasts have diverged. The lineage associated with the Carlsberg breweries in Denmark and that in the Czech Republic differ from each other and from a third lineage found in the Netherlands.

In the end, yeast is ancient and telling. Its genes reveal the story not just of brewing but also of domestication. Yeast evolved as our tastes evolved. We had less control of the process of yeast domestication than that of, say, pigeons, and yet the resulting diversity of yeasts, a kind of evolutionary Galapagos from which we sip, is the product both of natural selection and civilization.

But we still need to return to the original question: Did beer lead to agriculture, as Katz suggested? Possibly. Beer yeasts evolved early. The evidence of beer gardening based on the yeast evolutionary tree is roughly as early as the evidence of wheat farming.

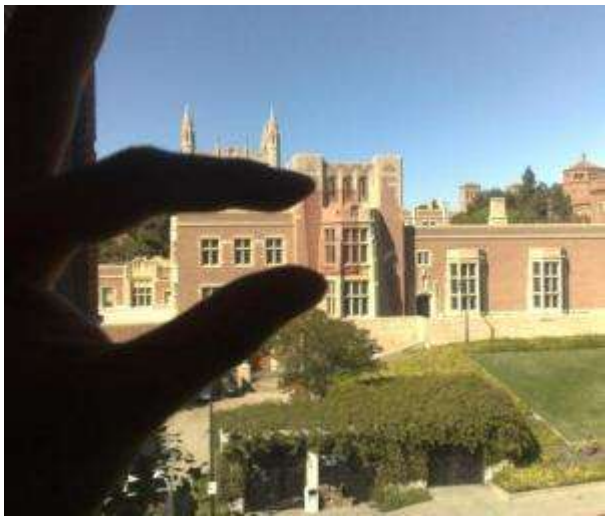
And so … maybe. What has become clear is that whether or not beer led to farming, yeast evolved hand in hand with agriculture nearly everywhere. Yeasts were there, holding, if not our hand, our cup. So it is that we have been drinking since the very beginning, from its prosperity. It is a prosperity that continues, a living cup that runneth over and will continue to do so as long as we are tempted by alcohol and bread.

And so remember the yeasts the next time you savor a cold one on the front porch with friends. Remember them when you break bread. Remember them, too, when you toast to, well … the evolution that flavors every sip and may have given rise to both bread and civilization, healthy food and beer.

For more about the stories of the wild species with which we interact, be they yeasts or tigers, read Rob Dunn's new book, The Wild Life of Our Bodies.

http://www.miller-mccune.com/science/humankinds-ascent-took-path-of-yeast-resistance-33652/

With Photovoltaic Polarizers, Devices Could Be Powered by Sunlight, Own Backlight



Polarizing organic photovoltaic film. (Credit: UCLA Engineering)

ScienceDaily (Aug. 9, 2011) — We've all worried about the charge on our smartphone or laptop running down when we have no access to an electrical outlet. But new technology developed by researchers at the UCLA Henry Samueli School of Engineering and Applied Science could finally help solve the problem.

The UCLA engineers have created a novel concept for harvesting and recycling energy for electronic devices -- one that involves equipping these devices' LCD screens with built-in photovoltaic polarizers, allowing them to convert ambient light, sunlight and their own backlight into electricity.

LCDs, or liquid crystal displays, are used in many of today's electronic devices, including smartphones, TV screens, computer monitors, laptops and tablet computers. They work by using two polarized sheets that let only a certain amount of a device's backlight pass through. Tiny liquid crystal molecules are sandwiched between the two polarizers, and these crystals can be switched by tiny transistors to act as light valves. Manipulating each light valve, or pixel, lets a certain amount of the backlight escape; millions of pixels are combined to create images on LCDs.

The UCLA Engineering team created a new type of energy-harvesting polarizer for LCDs called a polarizing organic photovoltaic, which can potentially boost the function of an LCD by working simultaneously as a polarizer, a photovoltaic device and an ambient light or sunlight photovoltaic panel.

Their research findings are currently available in the online edition of the journal *Advanced Materials* and will be published in a forthcoming print issue of the journal.

"I believe this is a game-changer invention to improve the efficiency of LCD displays," said Yang Yang, a professor of materials science at UCLA Engineering and principal investigator on the research. "In addition, these polarizers can also be used as regular solar cells to harvest indoor or outdoor light. So next time you are on the beach, you could charge your iPhone via sunlight."

From the point of view of energy use, current LCD polarizers are inefficient, the researchers said. A device's backlight can consume 80 to 90 percent of the device's power. But as much as 75 percent of the light generated is lost through the polarizers. A polarizing organic photovoltaic LCD could recover much of that unused energy.

"In the near future, we would like to increase the efficiency of the polarizing organic photovoltaics, and eventually we hope to work with electronic manufacturers to integrate our technology into real products," Yang said. "We hope this energy-saving LCD will become a mainstream technology in displays."

"Our coating method is simple, and it can be applied in the future in large-area manufacturing processes," said Rui Zhu, a postdoctoral researcher at UCLA Engineering and the paper's lead author.

"The polarizing organic photovoltaic cell demonstrated by Professor Yang's research group can potentially harvest 75 percent of the wasted photons from LCD backlight and turn them back into electricity," said Youssry Boutros, program director for the Intel Labs Academic Research Office, which supported the research. "The strong collaboration between this group at UCLA Engineering and other top groups has led to higher cell efficiencies, increasing the potential for harvesting energy. This approach is interesting in its own right and at the same time synergetic with several other projects we are funding through the Intel Labs Academic Research Office."

Ankit Kumar, a materials science and engineering graduate student at UCLA Engineering was the paper's second author.

Yang, who holds UCLA's Carol and Lawrence E. Tannas Jr. Endowed Chair in Engineering, is also faculty director of the Nano Renewable Energy Center at the California NanoSystems Institute at UCLA.

The research was supported by Intel through a gift to UCLA, and by the Office of Naval Research.

Story Source:
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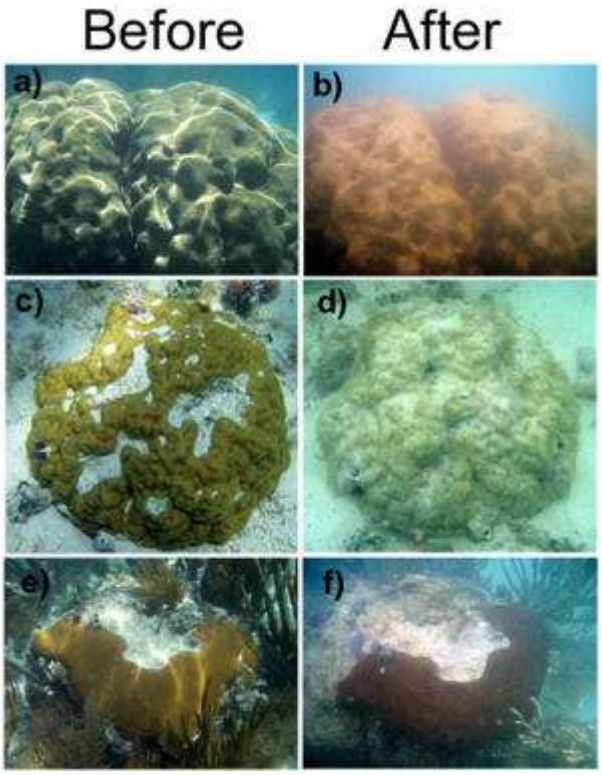
Journal Reference:

1. Rui Zhu, Ankit Kumar, Yang Yang. Polarizing Organic Photovoltaics. *Advanced Materials*, 2011; DOI: 10.1002/adma.201101514

http://www.sciencedaily.com/releases/2011/08/110810093839.htm

Severe Low Temperatures Devastate Coral Reefs in Florida Keys



Photographs of coral colonies from Admiral Reef before (panels a, c, e) and after (panels b, d, f) the cold-water anomaly. Photographs were taken in May 2009 (before) and February 2010 (after). Coral species shown are Montastraea faveolata (a, b), Porites astreoides (c, d), and Siderastrea siderea (e, f). "After" photographs of M. faveolata and P. astreoides (panels b, d) show dead colonies, whereas S. siderea (panel f) remained alive. Pigmentation of dead M. faveolata (panel b) is due to overgrowth of the coral skeleton by cyanobacteria and filamentous algae. (Credit: Dustin Kemp/University of Georgia)

ScienceDaily (Aug. 8, 2011) — Increased seawater temperatures are known to be a leading cause of the decline of coral reefs all over the world. Now, researchers at the University of Georgia have found that extreme low temperatures affect certain corals in much the same way that high temperatures do, with potentially catastrophic consequences for coral ecosystems. Their findings appear in the early online edition of the journal *Global Change Biology.*

Lead author Dustin Kemp, a postdoctoral associate in the UGA Odum School of Ecology, said the study was prompted by an abnormal episode of extended cold weather in January and February 2010. Temperatures on inshore reefs in the upper Florida Keys dropped below 12 C (54 F), and remained below 18 C (64 F) for two weeks. Kemp and his colleagues had planned to sample corals at Admiral Reef, an inshore reef off Key Largo, just three weeks after the cold snap. When they arrived, they discovered that the reef, once abundant in hard and soft corals, was essentially dead. "It was the saddest thing I've ever seen," Kemp said. "The large, reef-building corals were gone. Some were estimated to be 200 to 300 years old and had survived other catastrophic events, such as the 1998 El Niño bleaching event. The severe cold water appeared to kill the corals quite rapidly."

Odum School Professor William Fitt, Kemp's doctoral advisor and one of the paper's co-authors, realized that the team had a unique opportunity. "Nearly 100 years ago, Alfred Mayer described the temperature tolerance of different corals in the Dry Tortugas and found very similar results," Kemp said. "We decided to take the next step and learn how and why the cold temperatures caused the corals to die."

The researchers took samples of *Siderastrea siderea* -- one of the few reef-building corals to survive -- from Admiral Reef. They also took samples of three common Florida Keys corals, *Montastraea faveolata*, *Siderastrea siderea*and *Porites astreoides* from Little Grecian Reef, a nearby offshore reef that had not experienced the temperature anomaly to the extent of Admiral Reef. Kemp explained that Little Grecian Reef is far enough offshore that the cold-water temperatures were likely buffered by the warm waters of the Gulf Stream, which resulted in offshore coral reefs being less severely affected by the cold air mass that was pushed by an unusual weather pattern over much of the U.S. during that two-week period.

Back in the lab, they simulated the temperatures that had been recorded at Admiral Reef during the cold weather event, testing the different corals' physiological responses at 12 C and 16 C (61 F), and then, after the corals' exposure to the cold, returned the temperature to 20 C (68 F). They found that although responses varied depending on the coral species, in general the stress of extended cold temperatures had an effect similar to that of high temperatures.

Kemp explained that corals depend on *Symbiodinium*, a type of symbiotic algae that lives inside them, for nutrition. Through photosynthesis, the algae produce sugars, which are passed on to the corals. "The cold temperatures inhibited photosynthesis in the algae, leading to a potential net loss of carbon transferred from the algae to the coral," said Kemp. He said that each coral species had its own unique type of *Symbiodinium*, some of which were better able to tolerate and recover from cold temperatures than others.

All of the corals experienced a significant decrease in photosynthesis at 12 C. *Siderastrea siderea* and *M. faveolata* were able to handle the 16 C temperatures, but *P. astreoides* was not, and did not show signs of recovery once the temperature was returned to 20 C. *Siderastrea siderea* was the only coral able to recover.

"Corals and their symbiotic algae have a range of stress tolerance," said Kemp. "Some can handle moderate stress, some are highly sensitive, and some are in between. But extreme cold is just one stressor among many." Other threats to coral health include increased seawater temperatures, diseases, ocean acidification, and pollution. "Adding stress from wintertime cold episodes could not only quickly kill corals but also may have long-term effects," he said. "For corals found in the Florida Keys, winter is typically a 'non-stressful' time and corals bulk up on tissue reserves that are important for surviving potentially 'stressful' summertime conditions (i.e. coral bleaching)."

Kemp said that researchers at NOAA attribute the record-breaking cold anomaly to a negative trend in the North Atlantic oscillation, an atmospheric pressure pattern that influences the weather in the northern hemisphere. "They speculate that if the trend continues, these kinds of extreme cold events may become more frequent," he said.

Kemp stressed that the study's findings should not be interpreted to downplay the major role of higher temperatures on corals' decline. "The study shows that warming may not be the only climate-related problem for coral reefs in the future," he said.

Kemp also pointed out that it was not only the corals that were devastated by the cold snap. "The corals provide the framework for the entire reef ecosystem," he said. "The lobster, shrimp, clams, fish -- all the creatures that depend on the reef -- were affected too. The potential consequences for coral ecosystems are extremely alarming."

Besides Kemp and Fitt, the paper's coauthors were Clinton Oakley and Gregory Schmidt of the UGA Department of Plant Biology, Daniel Thornhill of the nonprofit Defenders of Wildlife and Bowdoin College, and Laura Newcomb of Bowdoin College. The research was supported by the National Science Foundation and Bowdoin College.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Georgia. The original article was written by Beth Gavrilles.

Journal Reference:

1. Dustin W. Kemp, Clinton A. Oakley, Daniel J. Thornhill, Laura A. Newcomb, Gregory W. Schmidt, William K. Fitt. Catastrophic mortality on inshore coral reefs of the Florida Keys due to severe low-temperature stress. *Global Change Biology*, 2011; DOI: 10.1111/j.1365-2486.2011.02487.x

http://www.sciencedaily.com/releases/2011/08/110808143003.htm

Billion-Year-Old Piece of North America Traced Back to Antarctica

Coats Land with its only rock outcrops, Littlewood (L) and Bertrab (B) nunataks. (Credit: Photo courtesy of Ian Dalziel)

ScienceDaily (Aug. 8, 2011) — An international team of researchers has found the strongest evidence yet that parts of North America and Antarctica were connected 1.1 billion years ago, long before the supercontinent Pangaea formed.

"I can go to the Franklin Mountains in West Texas and stand next to what was once part of Coats Land in Antarctica," said Staci Loewy, a geochemist at California State University, Bakersfield, who led the study. "That's so amazing."

Loewy and her colleagues discovered that rocks collected from both locations have the exact same composition of lead isotopes. Earlier analyses showed the rocks to be the exact same age and have the same chemical and geologic properties. The work, published online (ahead of print) in the September issue of the journal *Geology*, strengthens support for the so-called SWEAT hypothesis, which posits that ancestral North America and East Antarctica were joined in an earlier supercontinent called Rodinia.

The approximately 1.1 billion year old North American Mid-continent Rift System extends across the continent from the Great Lakes to Texas. Volcanic rocks associated with the rift, which appears to represent an aborted tectonic attempt to split the ancestral North American continent of Laurentia, are well exposed in the Keweenaw Peninsula of the Upper Peninsula of Michigan from which they take their name, the Keweenawan large igneous province. The rift extends in the subsurface beneath Minnesota, Iowa, Nebraska, Kansas and Oklahoma to the Franklin Mountains near El Paso, Texas where related rocks are exposed. In this latest report, Loewy, Ian Dalziel, research professor at The University of Texas at Austin, Richard Hanson of Texas Christian University and colleagues from several overseas institutions, find that rocks barely peeking through the ice in Coats Land, a remote part of the Antarctic continent south of the Atlantic Ocean basin, reflect a former continuation of the North American rift system. Loewy began her collaboration with Dalziel several years ago as a graduate student at the University of Texas at Austin.

Loewy et al. use new lead (Pb) isotopic data from the 1.1-billion-year-old rocks from Coats Land, to constrain the positions of Laurentia (ancestral North America) and Kalahari (ancestral southern Africa) in the 1-billion-year-old supercontinent, Rodinia. The Coats Land rocks are identical in age to both the Keweenawan large

igneous province of the North American mid-continent rift and the contemporaneous Umkondo large igneous province of southern Africa. Comparison of the isotopic compositions, however, unequivocally links the Coats Land rocks with the Keweenawan province. Together with paleomagnetic data this suggests that the Coats Land block was a piece of Laurentia near west Texas 1.1 billion years ago. Furthermore, the Coats Land block collided with the Kalahari Precambrian craton of Africa during a 1-billion-year-old collision. Based on this reconstruction, Laurentia collided with Kalahari along Antarctica's Maud mountain belt, which would represent a continuation of the 1-billion-year-old Grenville mountain belt of eastern and southern North America.

Thus the tiny Coats Land block of Antarctica is a 'tectonic tracer' providing critical clues to the geographic relationships between three of the major continents of the planet in the time interval 1.1 -- 1.0 billion years ago, just prior to the opening of the Pacific Ocean basin, the hypothesized 'Snowball Earth' glaciations, and the rise of multi-cellular life.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Geological Society of America.

Journal Reference:

1. S. L. Loewy, I. W. D. Dalziel, S. Pisarevsky, J. N. Connelly, J. Tait, R. E. Hanson, D. Bullen. Coats Land crustal block, East Antarctica: A tectonic tracer for Laurentia? *Geology*, 2011; DOI: 10.1130/G32029.1

http://www.sciencedaily.com/releases/2011/08/110808143006.htm

When East Met West Under the Buddha's Gaze

By HOLLAND COTTER

Stephen Chernin/Agence France-Presse — Getty Images

A Buddhist monk looked at a 3rd century Emaciated Siddhartha statue at the Asia Society Museum in New York

After what seemed like an endless run of geopolitical roadblocks, "The Buddhist Heritage of Pakistan: Art of Gandhara" has finally come, six months late, from Pakistan to Asia Society. Is the show worth all the diplomatic headaches it caused? With its images of bruiser bodhisattvas, polycultural goddesses and occasional flights into stratosphere splendor, it is.

That all but a handful of the 75 sculptures are from museums in Lahore and Karachi is in itself remarkable. Any effort to borrow ancient art from South Asia is fraught, even in the best of times. For an entire show of loans to make the trip, and in a period when Pakistan and the United States are barely on speaking terms, is miraculous. (Without the persistent effort of Pakistan's ambassador to the United Nations, Abdullah Hussain Haroon, the exhibition would almost certainly never have happened.) So the show has a cliffhanger back story as an attraction, and some monumental work, like the fantastic relief called "Vision of a Buddha's Paradise." (Dated to the fourth century A.D., it's a kind of flash-mob version of heaven.)

But most of what's here is neither dramatic nor grand: a chunk of a column; a head knocked from a statue; a panel sliced from some long-since-crumbled wall. Like most museums shows aiming for a big-picture view of a vanished world, it's a scattering of small effects: precious scraps and remnants. For every stand-back-and-stare item, there are a dozen others that require close-up scrutiny and informed historical imagining to make their point.

The multilayered and time-obscured history of ancient Gandhara is particularly difficult to grasp. The area, which encompassed what is now northwestern Pakistan and a sliver of Afghanistan, was a crossroads for

international traffic. If you had business that took you to or from the Indian subcontinent, you passed through Gandhara. If you were in the business of empire building, you made every effort to control it.

Persia, under Darius I, colonized the area in the sixth century B.C. Two centuries later Alexander the Great, a Macedonian Greek and a conquest addict, charged in and charged out, leaving behind a Hellenistic occupancy, which held firm even as Gandhara was absorbed into the Mauryan empire of India, South Asia's first great Buddhist power.

Over time Greco-Bactrians, Scythians and Parthians dominated the terrain. Then, around the first century A.D., the Kushans, originally nomads from the steppe-lands north of China, settled in, extending their reach down into the Indian subcontinent.

They were genuine cosmopolitans, linked to the Mediterranean, Persia and China, and tolerant of religions. It was under their aegis that Gandharan Buddhist art, compounded of foreign and local ingredients, flourished.

The exhibition, organized by Adriana Proser, a curator at Asia Society, begins by showing elements interacting. The first thing you see is a substantial female figure carved from the dark schist that was the common stone of the region. She has a funny look, familiar but not. She's dressed in a sort of cocktail-dress version of a Roman stola; her hairdo is pure 1970s Charlie's Angels, long but with back-flipped bangs.

Because she wears a helmet, she's been called Athena in the past, though she probably represents some regional genius loci modeled, at a remove of thousands of miles, on Greco-Roman prototypes. Another female figure with comparable features has more certain identity. Much as she resembles a Roman goddess of good fortune, the three clinging children she juggles mark her as the Buddhist deity Hariti, an infant-gobbling demon, who, after a little enlightenment, changed her ways.

The culture mix thickens further. On a fragmentary stone panel we find in relief a Persian-style column with an Indian nature goddess posed in front of it. A squat stone figure in baggy Kushan pants turns out to be Skanda, the Hindu god of war. And a stele devoted mainly to sober scenes from Buddha's life doubles as a playground for dozens of cupids.

The point is, Gandharan art was all over the map. Yet confusion sparked innovation. The first known figurative images of the Buddha are thought to have emerged from this region. So did, despite all the crazy components, an instantly recognizable sculptural style, on persuasive display in the second of the show's three sections.

Here we find the classic Gandharan Buddha. Dating from the second to fifth century A.D., he is a standing figure in an ankle-length tunic and a togalike cloak that falls in rhythmical folds, with hints at the shape of the body beneath. The facial features are symmetrical and crisply cut, and idealized, though on ethnic and aesthetic terms different from those of a Greek Apollo.

On the whole the image is naturalistic in a way that the purely Indian equivalents being carved from sandstone farther south were not. And the naturalism is especially pronounced in Gandharan images of bodhisattvas, those evolved beings who postpone nirvana to aid struggling creatures on earth.

One example from the Lahore Museum suggests a leader-of-the-pack biker: slightly paunchy, with a handle-bar mustache, a cascade of curls and a challenging stare. Technically, he's Maitreya, the Buddha of the future, though judging by his ornamental hardware — bicep bracelets, neck chains — he still has something to learn about the spiritual path of less-is-more.

The show's highlight, "Vision of a Buddha's Paradise," is in this section too, and culturally everything comes together here. The big Buddha seated at its center wears an off-the-shoulder robe, South Indian tropical attire, while a couple dozen of mini-bodhisattvas around him mix and match international fashions, with no two outfits, or gestures, or poses, quite the same. Two figures gaze raptly up at the Buddha; another, chin propped on hand, looks daydreamingly away; far below, two tiny observers feed lotuses to fish in a stream.

Was this really designed as a vision of Paradise? We don't know, though we might if we had some clue as to the piece's original setting, probably as one of several related panels in an architectural context. But, as is true of most Gandharan art collected before very recent times, such information went unrecorded, and an accurate sense of what this art meant to its makers and early viewers is lost.

Ms. Proser addresses the issue of context in the exhibition's last section, which is in its own gallery, by going with what we know: that much Buddhist art from Gandhara took the form of carved narrative panels depicting episodes from the life of the Buddha; that these panels once appeared on the walls of sanctuaries or cylindrical stupa mounds; and that many of the artists were entertaining storytellers.

Their skills are evident in the sequence of a dozen or so panels arranged around a stupalike structure in the gallery. In one, the Buddha's mother, Maya, anticipates his birth in a dream, and the artist has made her look like a Roman matron en déshabillé and asleep on her couch. But in a second panel, carved by a different artist and showing the infant Buddha being examined by a sage, we've switched countries and cultures: now we're in a land of turbans, boots and layered outwear.

A third episode takes place after the Buddha's enlightenment, as the lords of the four directions, essentially Vedic or Hindu beings, decorously offer him bowls of food. And a panel set next to that is packed with the figures of demons who had tried hard to prevent that enlightenment. The scene looks like a Wookiee convention. It's very funny, but also rich with information about armor and weaponry in use centuries ago.

For historians the value of an exhibition is in just such details, while for nonspecialists the main attraction is likely to be visual impact. Ordinarily, I'd rather look at Kushan-era Buddhist art carved farther south from rosy Indian sandstone than at sculpture made in cold, dark stone in Gandhara. (Asia Society had a show of both in 1986.) But that's just personal taste, and, besides, the show has changed my mind about this: it pulses with human warmth. That's one of the things we go to great art for, though in this case, and against very long odds, some of that great art has come to us.

"The Buddhist Heritage of Pakistan: Art of Gandhara" remains through Oct. 30 at Asia Society, 725 Park Avenue, at 70th Street; (212) 288-6400, asiasociety.org.

http://www.nytimes.com/2011/08/12/arts/design/the-buddhist-heritage-of-pakistan-art-of-gandhara-at-asia-society-review.html?ref=arts

Math Ability Is Inborn, New Research Suggests

Melissa Libertus is a post-doctoral fellow in the Department of Psychological and Brain Sciences at Johns Hopkins University's Krieger School of Arts and Sciences. (Credit: Will Kirk/JHU)

ScienceDaily (Aug. 8, 2011) — We accept that some people are born with a talent for music or art or athletics. But what about mathematics? Do some of us just arrive in the world with better math skills than others?

It seems we do, at least according to the results of a study by a team of Johns Hopkins University psychologists. Led by Melissa Libertus, a post-doctoral fellow in the Department of Psychological and Brain Sciences at the Krieger School of Arts and Sciences, the study -- published online in a recent issue of *Developmental Science* -- indicates that math ability in preschool children is strongly linked to their inborn and primitive "number sense," called an "Approximate Number System" or ANS.

Research reveals that "number sense" is basic to all animals, not just human beings. For instance, creatures that hunt or gather food use it to ascertain where they can find and procure the most nuts, plants or game and to keep track of the food they hunt or gather. We humans use it daily to allow us, at a glance, to estimate the number of open seats in a movie theater or the number of people in a crowded meeting. And it is measurable, even in newborn infants.

Though the link between ANS and formal mathematics ability already has been established in adolescents, Libertus says her team's is the first study to examine the role of "number sense" in children too young to already have had substantial formal mathematics instruction.

"The relationship between 'number sense' and math ability is important and intriguing because we believe that 'number sense' is universal, whereas math ability has been thought to be highly dependent on culture and language and takes many years to learn," she explained. "Thus, a link between the two is surprising and raises many important questions and issues, including one of the most important ones, which is whether we can train a child's number sense with an eye to improving his future math ability."

The team tested 200 4-year-old (on average) children on several tasks measuring number sense, mathematical ability and verbal ability. The children were rewarded for their participation with small trinkets, such as stickers and pencils.

During the number sense task, researchers asked the children to view flashing groups of blue and yellow dots on a computer screen and to estimate which color group of dots was more numerous. Counting wasn't an option, both because the dots were flashed so quickly and because most of the children were not yet skilled counters. The preschoolers would then verbally tell the tester whether the yellow or blue dots were more

numerous, and the tester would press the appropriate button. Some comparisons were easy (like comparing five yellow versus 10 blue dots). Others were much harder (like comparing five yellow versus six blue dots). Children were informed of right or wrong answers via a high- or low-pitched beep. (You can take a test similar to the one administered to the children online here: http://www.panamath.org/testyourself.php)

The children also were given a standardized test of early mathematics ability that measures numbering skills (verbally counting items on a page), number-comparison (determining which of two spoken number words is greater or lesser), numeral literacy (reading Arabic numbers), mastery of number facts (such as addition or multiplication), calculation skills (solving written addition and subtraction problems) and number concepts (such as answering how many sets of 10 are in 100.) This standardized test is often given to children between the ages of 3 and 8 years.

Lastly, the parents and guardians of the children were given an assessment that asked them to indicate each word on a list that their children had been heard to say. According to Libertus, this verbal test was administered because language and math abilities are to some extent linked through general intelligence, and the researchers wanted to make sure that the differences in math ability that they found were not just due to some children performing better on all kinds of tasks, or to some children feeling more comfortable being tested than others.

Libertus and her colleagues Lisa Feigenson and Justin Halberda, faculty members in the Department of Psychological and Brain Sciences, found that the precision of children's estimations correlated with their math skill. That is, the children who could make the finest-grained estimations in the dot comparison task (for example, judging that eight yellow dots were more than seven blue dots) also knew the most about Arabic numerals and arithmetic.

According to the researchers, this means that inborn numerical estimation abilities are linked to achievement (or lack thereof) in school mathematics.

"Previous studies testing older children left open the possibility that differences in instructional experience is what caused the difference in their number sense; in other words, that some children tested in middle or high school looked like they had better number sense simply because they had had better math instruction," Libertus said. "Unlike those studies, this one shows that the link between 'number sense' and math ability is already present before the beginning of formal math instruction."

Still in question, of course, is the root cause of the link between number sense and math ability. Do children born with better number sense have an easier time learning to count and to understand the symbolic nature of numbers? Or it is just that children born with less accurate number sense may end up avoiding math-related activities before they develop competency?

"Of course, many questions remain and there is much we still have to learn about this," Libertus said. "But what we have done raises many important avenues for future research and applications in education. One of the most basic is whether we can train children's Approximate Number System and thereby improve their math ability, and whether we can develop school math curricula that make use of children's ANS abilities and thus, help them grasp more advanced math concepts earlier."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Johns Hopkins University.

Journal Reference:

1. Melissa E. Libertus, Lisa Feigenson, Justin Halberda. Preschool acuity of the approximate number system correlates with school math ability. *Developmental Science*, 2011; DOI: 10.1111/j.1467-7687.2011.01080.x

http://www.sciencedaily.com/releases/2011/08/110808152428.htm

Were the best world leaders mentally ill?

12:15 29 July 2011
Books

Michael Bond, contributor

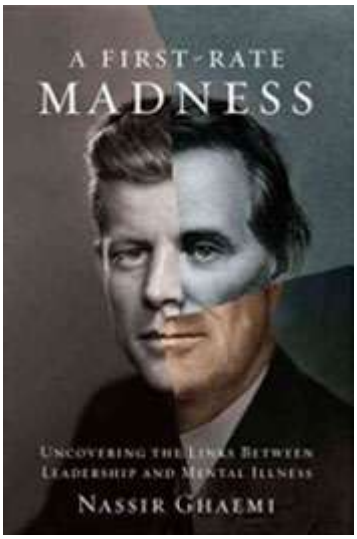
Was JFK a successful, drug-fuelled maniac, and Nixon a sane failure? (Image: Bettmann/Corbis)

In A First-Rate Madness, *Nassir Ghaemi argues that psychiatric disorders were the making of some of the great world leaders*

IT HAS become fashionable to talk up the positive side of mental illness, to explain the persistence of conditions such as severe depression in terms of the benefits they bring to the people who experience them. For example, the tendency of depressed people to ruminate - generally considered an undesirable trait because it fuels negative thinking - could actually deepen their understanding of their problems and enhance decision-making.

There is little empirical data to support this position at present, and its many detractors point out, for instance, that depressed people tend to ruminate in an irrational way that is unlikely to lead to enlightening insights. This has not deterred Nassir Ghaemi, a professor of psychiatry at Tufts University School of Medicine in Boston, whose latest book, *A First-Rate Madness*, pushes the rose-tinted view of mental illness into new territory. He argues that the best leaders during troubled times are those with mood disorders, since their illness enhances the very qualities that crisis management demands. In times of crisis, he concludes, "we are better off being led by mentally ill leaders than by mentally normal ones".

Such a provocative hypothesis requires solid evidence. Unfortunately Ghaemi appears to have very little, at least to support his fundamental assertion that mental illness is necessary for the flourishing of the key leadership traits he identifies. If realism, empathy, resilience and creativity - useful survival tools under any conditions - are heightened only by insanity, we should ask why mental pathology is not more widespread. His assertion that someone who is mentally healthy "is insensitive to suffering" and therefore incapable of empathising with others also seems absurd.



While few would disagree with his premise that leaders who are successful in peacetime are often failures in war, and vice versa, the book's focus on personality traits sits uneasily with recent research on social identity and group dynamics, which suggests that leadership has more to do with the relationship between a leader and their followers than an individual's character. Thus Winston Churchill, John F. Kennedy, Abraham Lincoln, Sonia Gandhi and even George W. Bush were influential at crucial times because they worked hard to be seen to be acting in the collective interests of the groups they represented.

A First-Rate Madness takes a very different approach, applying the tools of psychology and psychiatry to historical figures to ascertain how their state of mind dictated their behaviour. It makes for an interesting analysis. However, "psychological history", as the author dubs his discipline, is an inexact science; often you get the feeling he is shoehorning his protagonists into characterisations that do not convincingly fit. While JFK's success is put down to his use of steroids and amphetamines, which may have made him manic, Hitler was a failure because his abuse of methamphetamine made him too manic. Richard Nixon - generally

considered successful, but also paranoid and depressive for much of his peacetime presidency - is re-diagnosed as mentally healthy and therefore ill-equipped to deal with a crisis such as Watergate.

Ghaemi acknowledges, three pages from the end of the book, the uncertainty in making such inferences, admitting he could never prove that Churchill's depression was even related to his realistic assessment of Nazism, let alone "key" to it. This modesty would have been better placed at the start of the book, along with some explanation of the causal mechanisms that might be involved. How exactly does depression - generally a highly isolating experience - deepen someone's empathy?

One of Ghaemi's stated aims is to dismantle the cultural stigma that surrounds mental illness. This would be welcome but instead he comes close to glorifying it, which hardly seems like the appropriate response when so much of his material is speculative.

Book Information
A First-Rate Madness: Uncovering the links between leadership and mental illness
by Nassir Ghaemi
Penguin
$27.95

http://www.newscientist.com/blogs/culturelab/2011/07/were-the-best-world-leaders-mentally-ill.html?DCMP=OTC-rss&nsref=online-news

'Amino Acid Time Capsule': New Way to Date the Past

Bithynia shell. (Credit: Photo by Dr Richard Preece)

ScienceDaily (Aug. 8, 2011) — Scientists at the University of York, using an 'amino acid time capsule', have led the largest ever programme to date the British Quaternary period, stretching back nearly three million years.

It is the first widespread application of refinements of the 40-year-old technique of amino acid geochronology. The refined method, developed at York's BioArCh laboratories, measures the breakdown of a closed system of protein in fossil snail shells, and provides a method of dating archaeological and geological sites.

Britain has an unparalleled studied record of fossil-rich terrestrial sediments from the Quaternary, a period that includes relatively long glacial episodes -- known as the Ice Age --interspersed with shorter 'interglacial' periods where temperatures may have exceeded present day values.

However, too often the interglacial deposits have proved difficult to link to global climatic signals because they are just small isolated exposures, often revealed by quarrying..

Using the new method, known as amino acid racemization, it will be possible to link climatic records from deep sea sediments and ice cores with the responses of plants and animals, including humans, to climate change over the last three million years. The research is published in the latest issue of *Nature*.

The new method was developed by Dr Kirsty Penkman, of the Department of Chemistry, alongside Prof. Matthew Collins of the Department of Archaeology at York, and measures the the extent of protein degradation in calcareous fossils such as mollusc shells. It is based on the analysis of intra-crystalline amino acids -- the building blocks of protein --preserved in the fossil opercula (the little 'trapdoor' the snail uses to shut itself away inside its shell) of the freshwater gastropod *Bithynia*. It provides the first single method that is able to accurately date such a wide range of sites over this time period.

Dr Penkman said: "The amino acids are securely preserved within calcium carbonate crystals of the opercula. This crystal cage protects the protein from external environmental factors, so the extent of internal protein degradation allows us to identify the age of the samples. In essence, they are a protein time capsule.

"This framework can be used to tell us in greater detail than ever before how plants and animals reacted to glacial and interglacial periods, and has helped us establish the patterns of human occupation of Britain, supporting the view that these islands were deserted in the Last Interglacial period."

In a close collaboration with palaeontologist Dr. Richard Preece in the Department of Zoology at the University of Cambridge, the study examined a total of 470 fossil remains from 71 sites in the UK and three on continental Europe. The method proved highly reliable with more than 98 per cent of samples yielding useful results, resulting in the largest ever geochronological programme of the British Pleistocene.

Professor Collins said: "When we started this work 11 years ago, we thought it was going to be relatively straightforward to identify a good material for dating, but the first 3 years of research on shells showed that the stability of the mineral itself was vital. The tiny trapdoor of a snail proved to be the key to success."

Dr Preece added: "Luckily, fossil opercula are common in Quaternary sediments around the world, so the new technique can be used to build regional Ice Age chronologies everywhere, giving it enormous international scope."

Vital to the study were the inter-disciplinary collaborations with Quaternary scientists, the core team of which involved researchers at the Department of Geography, University of Durham; Institute of Archaeology and Antiquity, University of Birmingham; Institute of Archaeology, University College London; the Netherlands Centre for Biodiversity, Leiden and the Department of Palaeontology, The Natural History Museum.

The analyses were funded by English Heritage, Natural Environment Research Council and the Wellcome Trust. The research is a contribution to the Ancient Human Occupation of Britain (AHOB) project funded by the Leverhulme Trust.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of York.

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http://www.sciencedaily.com/releases/2011/08/110804081850.htm

Reality check: Why dreams aren't what they seem

- 10 August 2011 by Anil Ananthaswamy

Magazine issue 2825.

The body of your dreams (Image: Henrik Sorenson/Getty)

The able-bodied dreams of people with a variety of disabilities challenge the theory that dreams are mere echoes of your day

"WE HAD to flee. After a frantic race I started walking, carrying my daughter in my arms..." No matter how exciting to the dreamer, listening to people recount their dreams is notoriously dull. But reports such as this one, from someone who was born paralysed from the waist down, are perhaps more interesting.

This is because a flurry of recent dream studies in people with disabilities are challenging our understanding of why we dream. The results seem to suggest that dreams, besides being a surreal echo of our waking lives, have a reality of their own: they may even spring from innate, fully functional representations of our body and sensory perceptions that do not always match real-life situations.

The idea that dreams are linked to our waking reality - known as the continuity hypothesis - can be traced back to Sigmund Freud. The basic premise is that our dreams are determined by the thoughts, feelings and events that we have experienced during our waking hours, whether recently or further into the past.

While this hypothesis cannot account for everything - why we occasionally fly in our dreams, for example - it is the dominant idea, says dream researcher Martin Schredl at the Central Institute of Mental Health in Mannheim, Germany. He says there is a thematic continuity between waking and dreaming: "Dreams evoke specific emotions and reactions within the dreamer, and these are very closely related to actual waking-life issues."

To explore whether dreams are indeed a one-way street from the outside in, Alan Hobson of Harvard Medical School in Boston and Ursula Voss at the University of Bonn in Germany, and colleagues, collected dream reports from four people born with paraplegia, 10 people who were born deaf and did not speak, and 36 able-bodied people acting as controls. The volunteers were asked to write down their dreams for two weeks, paying particular attention to the frequency and intensity of their movements and sensory experiences.

When the team analysed the dream reports, they were in for a surprise. About 80 per cent of the dream narratives of the deaf participants gave no indication of their impairment: many spoke in their dreams, while others could hear and understand spoken language. The dream reports of the people born paralysed revealed something similar: they often walked, ran or swam, none of which they had ever done in their waking lives (see "Whose dream is it anyway?"). Most importantly, there was no difference between the number of such bodily movements in the dream reports of the people with paraplegia and in those of the deaf and able-bodied subjects (*Consciousness and Cognition*, DOI: 10.1016/j.concog.2010.10.020).

In June, another group reported similar results. A team led by Marie-Thérèse Saurat of the Pitié-Salpêtrière Hospital in Paris, France, analysed the dreams of 15 people who were either born with paraplegia or acquired it as a result of a spinal-cord injury, and compared them with dreams of 15 able-bodied volunteers. Dream reports collected over six weeks showed that all but one person with paraplegia dreamed of being physically active and voluntarily moved their legs in their dreams. And people with paraplegia - even those born with the disability - dreamed of walking just as often as the healthy controls (*Consciousness and Cognition*, DOI: 10.1016/j.concog.2011.05.015).

Voss admits that while it is likely that the dreams of the people with disabilities would have been influenced by witnessing able-bodied people doing what the dreamer could not, she thinks it runs deeper than that. Why? Because some of the deaf, non-speaking participants said that rather than seeing themselves speak in their dream, they simply knew that they were doing it. Voss reckons this implies that "dreams are tapping into representations of limbs and movements that exist in the brain and which are independent of our waking reality".

She and Hobson argue that rapid-eye-movement (REM) sleep, the period in which we dream, prepares the brain for motor and sensory experiences before we encounter these experiences in real life. Babies and fetuses also experience REM sleep. The pair say the recent dream studies suggest that our brain has the genetically determined ability to generate experiences that mimic life, including having fully functioning limbs and senses, and that people who are born deaf or paralysed are likely tapping into these parts of the brain when they dream about things they cannot do while awake.

Ivan Limosani, a psychiatrist and dream researcher at the San Paolo Hospital in Milan, Italy, also reckons we need to rethink dream theory. "I don't agree with the continuity hypothesis," he says. "I think that the activation of the brain during dreams is always the same" regardless of daily experience. He adds that it is a state of the mind that arises from "a primitive part of our brain".

Schredl is far from convinced the continuity hypothesis is dead, however. He thinks that continuity between dreams and waking life might lie in the basic emotions and thinking patterns experienced in dreams, rather than in the particulars such as whether or not the dreamer's body is fully functional. He reasons that if you were feeling a certain way during the day, then those feelings and emotions are likely to show up in dreams, even if the scenarios do not match the physical reality.

Hobson, meanwhile, describes the relationship between dreams and wakefulness as a two-way street, but "a two-way street that is first travelled from inside out". In other words, dreams influence waking life more significantly than the other way around. This reversal of the conventional view has profound implications, he says. Dreams could be laying the groundwork for real life, and without them our brain may not be prepared for waking experiences. But Hobson admits "that's an intuition" that needs to be empirically tested.

The next step for Voss and her colleagues is to match EEG signals to dream reports, allowing them to investigate how the brain activity of their subjects ties in with what they report to be dreaming about.

Voss also plans to use a technique that delivers a mild electric current to parts of dreamers' brains, disrupting activity without waking them, to see if this changes the nature of their dreams. "We are going beyond the subjective dream report by actively altering the dreams," she says.

Whose dream is it anyway?

Rather than reflecting their physical impairment, the dreams of people disabled from birth resemble those of people free of disabilities. Here are just a few examples.

"I am in a huge, beautiful white house in Africa... The windows are big and everything is very light. I watch the people passing me by. Suddenly my big love comes by. He looks and says: 'I will always love you'. He walks away. I freeze." *Person born deaf and who does not speak*

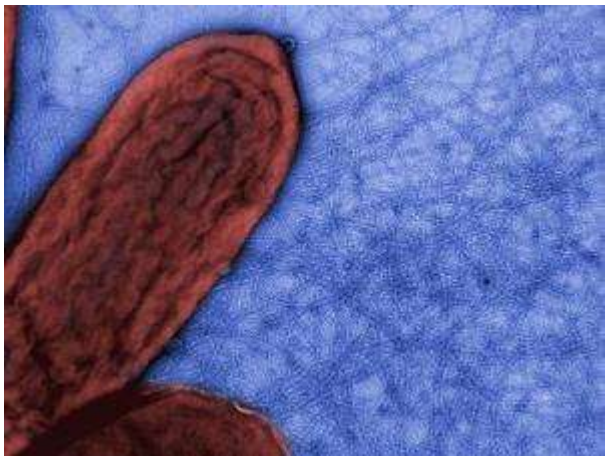
"I was supposed to and wanted to sing in the choir. I see a stage on which some singers, male and female, are standing... I am asked if I want to sing with them. 'Me?' I ask, 'I don't know if I am good enough.' And already I am standing on the stage with the choir. In the front row, I see my mother, she is smiling at me... It is a nice feeling to be on stage and able to chant." *Person born deaf and who does not speak*

"I was not in a wheelchair but walking to a nightclub, to go dancing." *Person born with paraplegia*

"I walk along a beach. My naked feet are immersed in the water. I walk further and further into the ocean. The water is very cold but I don't shiver, just the opposite, it is a very nice feeling." *Person born with paraplegia*

http://www.newscientist.com/article/mg21128253.600-reality-check-why-dreams-arent-what-they-seem.html?full=true&print=true

New Conducting Properties Discovered in Bacteria-Produced Wires



A transmission electron micrograph of Geobacter sulfurreducens cells synthesizing a network of protein nanofilaments which exhibit metallic-like conductivity. (Credit: Geobacter photo by Anna Klimes and Ernie Carbone, UMass Amherst)

ScienceDaily (Aug. 8, 2011) — The discovery of a fundamental, previously unknown property of microbial nanowires in the bacterium Geobacter sulfurreducens that allows electron transport across long distances could revolutionize nanotechnology and bioelectronics, says a team of physicists and microbiologists at the University of Massachusetts Amherst.

Their findings reported in the Aug. 7 advance online issue of *Nature Nanotechnology* may one day lead to cheaper, nontoxic nanomaterials for biosensors and solid state electronics that interface with biological systems.

Lead microbiologist Derek Lovley with physicists Mark Tuominen, Nikhil Malvankar and colleagues, say networks of bacterial filaments, known as microbial nanowires because they conduct electrons along their length, can move charges as efficiently as synthetic organic metallic nanostructures, and they do it over remarkable distances, thousands of times the bacterium's length.

Networks of microbial nanowires coursing through biofilms, which are cohesive aggregates of billions of cells, give this biological material conductivity comparable to that found in synthetic conducting polymers, which are used commonly in the electronics industry.

Lovley says, "The ability of protein filaments to conduct electrons in this way is a paradigm shift in biology and has ramifications for our understanding of natural microbial processes as well as practical implications for environmental clean-up and the development of renewable energy sources."

The discovery represents a fundamental change in understanding of biofilms, Malvankar adds. "In this species, the biofilm contains proteins that behave like a metal, conducting electrons over a very long distance, basically as far as you can extend the biofilm."

Tuominen, the lead physicist, adds, "This discovery not only puts forward an important new principle in biology but in materials science. We can now investigate a range of new conducting nanomaterials that are living, naturally occurring, nontoxic, easier to produce and less costly than human-made. They may even allow us to use electronics in water and moist environments. It opens exciting opportunities for biological and energy applications that were not possible before."

The researchers report that this is the first time metallic-like conduction of electrical charge along a protein filament has been observed. It was previously thought that such conduction would require a mechanism involving a series of other proteins known as cytochromes, with electrons making short hops from cytochrome to cytochrome. By contrast, the UMass Amherst team has demonstrated long-range conduction in the absence of cytochromes. The Geobacter filaments function like a true wire.

In nature, Geobacter use their microbial nanowires to transfer electrons onto iron oxides, natural rust-like minerals in soil, that for Geobacter serve the same function as oxygen does for humans. "What Geobacter can do with its nanowires is akin to breathing through a snorkel that's 10 kilometers long," says Malvankar.

The UMass Amherst group had proposed in a 2005 paper in Nature that Geobacter's nanowires might represent a fundamental new property in biology, but they didn't have a mechanism, so were met with considerable skepticism. To continue experimenting, Lovley and colleagues took advantage of the fact that in the laboratory Geobacter will grow on electrodes, which replace the iron oxides. On electrodes, the bacteria produce thick, electrically conductive biofilms. In a series of studies with genetically modified strains, the researchers found the metallic-like conductivity in the biofilm could be attributed to a network of nanowires spreading throughout the biofilm.

These special structures are tunable in a way not seen before, the UMass Amherst researchers found. Tuominen points out that it's well known in the nanotechnology community that artificial nanowire properties can be changed by altering their surroundings. Geobacter's natural approach is unique in allowing scientists to manipulate conducting properties by simply changing the temperature or regulating gene expression to create a new strain, for example. Malvankar adds that by introducing a third electrode, a biofilm can act like a biological transistor, able to be switched on or off by applying a voltage.

Another advantage Geobacter offers is its ability to produce natural materials that are more eco-friendly and quite a bit less expensive than human-made. Quite a few of today's nanotech materials are expensive to produce, many requiring rare elements, says Tuominen. Geobacter is a true natural alternative. "As someone who studies materials, I see the nanowires in this biofilm as a new material, one that just happens to be made by nature. It's exciting that it might bridge the gap between solid state electronics and biological systems. It is biocompatible in a way we haven't seen before."

Lovley quips, "We're basically making electronics out of vinegar. It can't get much cheaper or more 'green' than that."

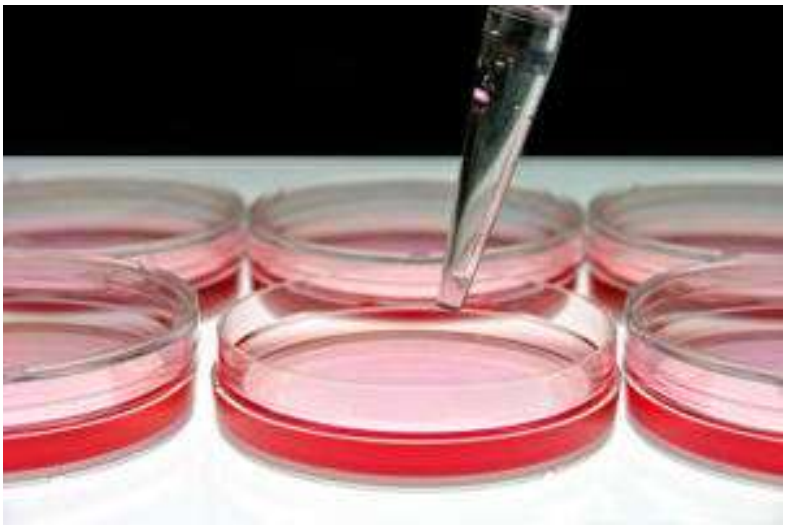
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Massachusetts at Amherst, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Nikhil S. Malvankar, Madeline Vargas, Kelly P. Nevin, Ashley E. Franks, Ching Leang, Byoung-Chan Kim, Kengo Inoue, Tünde Mester, Sean F. Covalla, Jessica P. Johnson, Vincent M. Rotello, Mark T. Tuominen, Derek R. Lovley. Tunable metallic-like conductivity in microbial nanowire networks. *Nature Nanotechnology*, 2011; DOI: 10.1038/nnano.2011.119

http://www.sciencedaily.com/releases/2011/08/110807143831.htm

Cell-Based Alternative to Animal Testing? Genomic Biomarker Signature Can Predict Skin Sensitizers, Study Finds



New research demonstrates that the response of laboratory grown human cells can now be used to classify chemicals as sensitizing, or non-sensitizing, and can even predict the strength of allergic response, so providing an alternative to animal testing. (Credit: © Chee-Onn Leong / Fotolia)

ScienceDaily (Aug. 8, 2011) — European legislation restricts animal testing within the pharmaceutical and cosmetic industries and companies are increasingly looking at alternative systems to ensure that their products are safe to use. Research published in BioMed Central's open access journal *BMC Genomics* demonstrates that the response of laboratory grown human cells can now be used to classify chemicals as sensitizing, or non-sensitizing, and can even predict the strength of allergic response, so providing an alternative to animal testing.

Allergic contact dermatitis can result in itching and eczema and is often due to repeated exposure to chemicals at work or in everyday life such as machine oil, detergents, soaps, and cosmetics. Unless the source of the sensitizing chemical is found the resulting rashes can be an ongoing source of misery for the sufferer. The 2009, 7th Amendment to the Cosmetic Directive bans testing of cosmetic products and ingredients on animals meaning that there is currently no way of ensuring new products are hypoallergenic.

Researchers from Lund University in Sweden used genome-wide profiling to measure the response of a human myeloid leukemia cell line to known chemicals. From this they defined a 'biomarker signature' of 200 genes, which could accurately discriminate between sensitizing and non-sensitizing chemicals. By comparing this signature with the known action of these chemicals they were also able to use this system to predict sensitizing potency.

Prof Borrebaeck said, "REACH (Registration, Evaluation, and Authorization of Chemicals) regulation requires that all new and existing chemicals within the European Union are tested for safety. The number of chemicals this includes is over 30,000 and is increasing all the time. Our lab-based alternative to animal testing, although in an early stage of production, is faster, out-performs present alternatives, and, because the cells are human in origin, is more relevant. It provides a way of ensuring the continued safety of consumers and users and, by identifying chemicals and products with low immunogenicity, reducing the suffering due to eczema."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by BioMed Central, via EurekAlert!, a service of AAAS.

Journal Reference:

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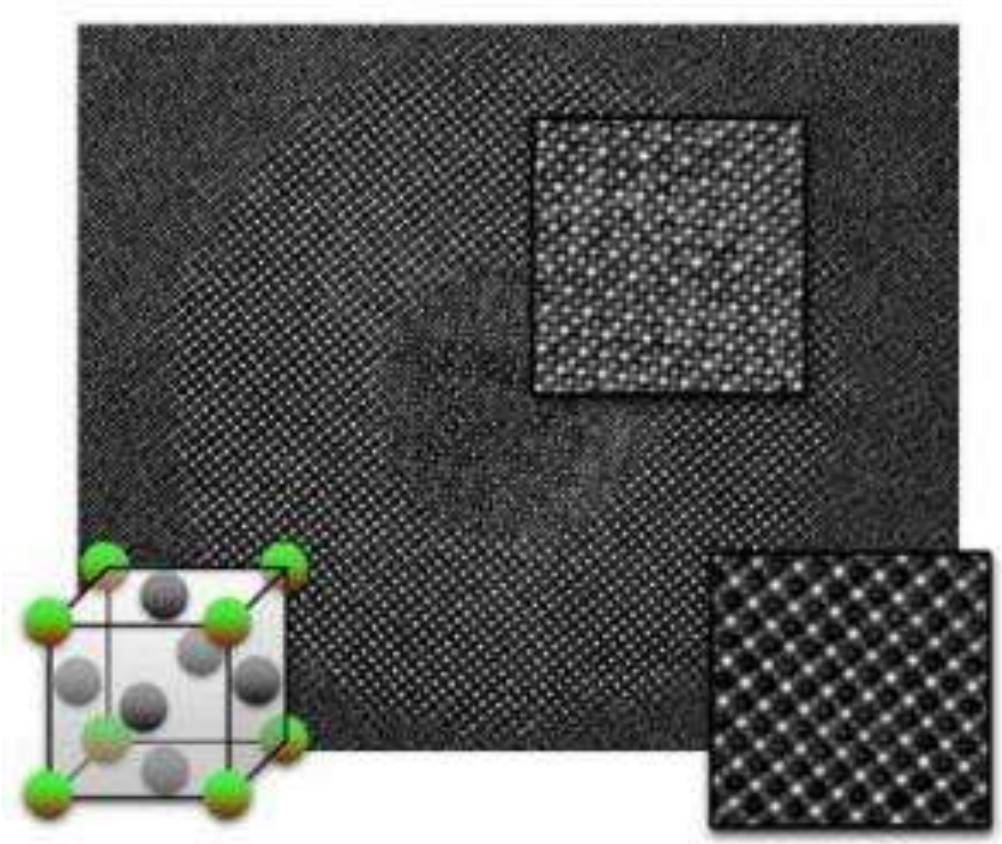
http://www.sciencedaily.com/releases/2011/08/110807220534.htm

Nanoparticle Size Is Readily Controlled to Make Stronger Aluminum Alloys



The L12 structure is shown at lower left, with aluminum atoms in gray and scandium or lithium atoms reddish green. In images of a core-shell nanoparticle made by NCEM's TEAM microscope, each dot shows the top of a column of atoms; the kinds of atoms in each column can be calculated from the brightness and contrast of the dots. The aluminum matrix has a face-centered cubic structure in which all the atoms are aluminum, while in the L12 structure the face-centered positions are also aluminum. But in the core of the nanoparticle (upper right), the columns at the corners of the L12 unit cell are a mix of aluminum, lithium, and scandium atoms, while in the surrounding shell (lower right), the corner columns are a mix of aluminum and lithium. (Credit: Lawrence Berkeley National Laboratory)

ScienceDaily (Aug. 8, 2011) — Long before they knew they were doing it -- as long ago as the Wright Brother's first airplane engine -- metallurgists were incorporating nanoparticles in aluminum to make a strong, hard, heat-resistant alloy. The process is called solid-state precipitation, in which, after the melt has been quickly cooled, atoms of alloying metals migrate through a solid matrix and gather themselves in dispersed particles measured in billionths of a meter, only a few-score atoms wide.

Key to the strength of these precipitation-hardened alloys is the size, shape, and uniformity of the nanoparticles and how stable they are when heated. One alloy with a highly successful combination of properties is a particular formulation of aluminum, scandium, and lithium, whose precipitates are all nearly the same size. It was first made at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) in 2006 by a team led by Velimir Radmilović and Ulrich Dahmen of the Materials Sciences Division.

These scientists and their colleagues have now combined atomic-scale observations with the powerful TEAM microscope at Berkeley Lab's National Center for Electron Microscopy (NCEM) with atom-probe tomography and other experimental techniques, and with theoretical calculations, to reveal how nanoparticles consisting of cores rich in scandium and surrounded by lithium-rich shells can disperse in remarkably uniform sizes throughout a pure aluminum matrix.

"With the TEAM microscope we were able to study the core-shell structure of these nanoprecipitates and how they form spheres that are nearly the same in diameter," says Dahmen, the director of NCEM and an author of the *Nature Materials* paper describing the new studies. "What's more, these particles don't change size over time, as most precipitates do. Typically, small particles get smaller and large particles get larger, a process called ripening or coarsening, which eventually weakens the alloys. But these uniform core-shell nanoprecipitates resist change."

Evolution of an alloy

In the aluminum-scandium-lithium system the researchers found that, after the initial melt, a simple two-step heating process creates first the scandium-rich cores and then the lithium-rich shells of the spherical particles. The spheres self-limit their growth to achieve the same outer dimensions, yielding a lightweight, potentially heat- and corrosion-resistant, superstrong alloy.

"Scandium is the most potent strengthener for aluminum," says NCEM's Radmilović, who is also a professor of metallurgy at the University of Belgrade, Serbia, and an author of the *Nature Materials* paper. "Adding less than one percent scandium can make a dramatic difference in mechanical strength, fracture resistance, corrosion resistance -- all kinds of properties." Because scandium diffuses very slowly through the solid aluminum matrix, the solid mix must be heated to a high temperature (short of melting) before scandium will precipitate.

Lithium is the lightest of all metals (only hydrogen and helium are lighter) and brings not only lightness to an aluminum alloy but, potentially, strength as well. Lithium diffuses much more rapidly than scandium, at much lower temperature.

"The problem is that, by itself, lithium may not live up to its promise," says Dahmen, a long-time collaborator with Radmilović. "The trick is to convince the lithium to take on a useful crystalline structure, namely $L1_2$."

The $L1_2$ unit cell resembles a face-centered cubic cell, among the simplest and most symmetric of crystal structures. Atoms occupy each corner of an imaginary cube and are centered in the cube's six faces; in the $L1_2$ structure, the kinds of atoms at the corners may differ from those at the centers of the faces. For alloy inclusions it's one of the strongest and stablest of structures because, as Dahmen explains, "once atoms are in place in $L1_2$, it's difficult for them to move."

Dahmen credits Radmilović with the "intuition" to alloy both scandium and lithium with aluminum, heating and cooling the material in a specific series of steps. That intuition was based on Radmilović's long experience with the separate properties of aluminum-lithium and aluminum-scandium alloys and a deep understanding of how they were likely to interact. He drew up a recipe for the proportions of ingredients in the initial melt and how to cool and rewarm them.

The key to the process was to use lithium as a kind of catalyst to force a "burst of nucleation" in the scandium. After the three metals are mixed, melted, and quickly cooled or quenched, lithium serves to lower the heating needed to coax scandium to form dense core structures -- although the solid mix must still be heated to 450 degrees Celsius (842 Fahrenheit) for 18 hours to form these cores, made of aluminum, lithium, and scandium. The cores average a little over nine nanometers in diameter but are not uniform in size.

Next the alloy is heated again, this time to 190˚ Celsius (374˚ F) for four hours. At the lower temperature the scandium is immobile; the freely-moving lithium forms a shell around the scandium-rich cores, much as water in a cloud crystallizes around a speck of dust to make a snowflake. The shells average about 10.5 nanometers in thickness, but their thickness is not uniform.

What's remarkable, though, is that when a core is thicker than the average, the shell is thinner than the average, and vice versa: the smaller the core, the faster the shell grows. Core size and shell size are "anticorrelated" and the result is "size focused." Whole spheres still vary somewhat, but the differences are much less than among the cores alone or the shells alone.

The structure of the cores and shells embedded in aluminum seems equally remarkable. Pure aluminum itself has a face-centered-cubic structure, and this structure is seamlessly repeated by the $L1_2$ structure of both the cores and the shells, perfectly joined with no dislocations at the interfaces between core, shell, and matrix.

Dahmen says, "It's the scandium-rich cores that convince the lithium to take on the useful $L1_2$ structure."

Joining experiment with theory

Using the TEAM microscope and a special imaging technique to look down at the tops of the regular rows of columns of atoms, the $L1_2$ structure reveals itself in groups of interlocking squares, with four columns of atoms at the corners and five columns of atoms at the lined-up centers of the faces.

In pure aluminum, all the dots are the same brightness. In the shells and cores, however, the corner columns and the face-centered columns differ in contrast -- the face-centered columns are pure aluminum but the corner columns are mixed. By supplementing the high-resolution TEAM images with data from other experimental techniques it was possible to use brightness and contrast to calculate the kinds of atoms in each column.

By employing first-principles calculations, team members Colin Ophus and Mark Asta were able to model the effect of lithium on the solid-state precipitation of scandium, stimulating a sudden burst of nucleation, and also to understand why, because of the thermodynamic properties of the two metals interacting with aluminum and with each other, the precipitates are so uniform and stable.

Radmilović says, "Colin and Mark showed that lithium and scandium like each other. They also showed that by using the aluminum columns as a standard, we can calculate the intensity of the scandium and lithium by the brightness of the spot." In the shells, the corner columns contain aluminum and about 10 percent lithium. In the cores, the corner columns contain all three metals.

Dahmen says, "In recent years there has been a rapid increase in the use of 'integrative microscopy' -- using a variety of techniques such as high-angular annular dark-field imaging, high-resolution phase contrast, and energy-filtered imaging and spectroscopy to attack a single problem. The TEAM microscope, which is corrected for both chromatic and spherical aberration, is unique in its ability to do all these techniques with high resolution. Understanding why nanoinclusions in aluminum-scandium-lithium are uniform is one of the best examples for the need to use integrative microscopy."

As good an alloy as aluminum-scandium-lithium is, its use may be limited by the cost of rare scandium, presently ten times the price of gold. By understanding how the alloy achieves its remarkable characteristics, the researchers fully expect that other systems with core-shell precipitates can be controlled by the same mechanisms, leading to new kinds of alloys with a range of desirable properties.

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Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by DOE/Lawrence Berkeley National Laboratory.

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http://www.sciencedaily.com/releases/2011/08/110807143841.htm

Why Plant 'Clones' Aren't Identical

A new study of plants that are reproduced by 'cloning' has shown why cloned plants are not identical. (Credit: © Vasiliy Koval / Fotolia)

ScienceDaily (Aug. 8, 2011) — A new study of plants that are reproduced by 'cloning' has shown why cloned plants are not identical.

Scientists have known for some time that 'clonal' (regenerant) organisms are not always identical: their observable characteristics and traits can vary, and this variation can be passed on to the next generation. This is despite the fact that they are derived from genetically identical founder cells.

Now, a team from Oxford University, UK, and King Abdullah University of Science and Technology, Saudi Arabia, believe they have found out why this is the case in plants: the genomes of regenerant plants carry relatively high frequencies of new DNA sequence mutations that were not present in the genome of the donor plant.

The team report their findings in this week's *Current Biology*.

'Anyone who has ever taken a cutting from a parent plant and then grown a new plant from this tiny piece is actually harnessing the ability such organisms have to regenerate themselves,' said Professor Nicholas Harberd of Oxford University's Department of Plant Sciences, lead author of the paper. 'But sometimes regenerated plants are not identical, even if they come from the same parent. Our work reveals a cause of that visible variation.'

Using DNA sequencing techniques that can decode the complete genome of an organism in one go (so-called 'whole genome sequencing') the researchers analysed 'clones' of the small flowering plant 'thalecress' (*Arabidopsis*). They found that observable variations in regenerant plants are substantially due to high frequencies of mutations in the DNA sequence of these regenerants, mutations which are not contained in the genome of the parent plant.

'Where these new mutations actually come from is still a mystery,' said Professor Harberd. 'They may arise during the regeneration process itself or during the cell divisions in the donor plant that gave rise to the root cells from which the regenerant plants are created. We are planning further research to find out which of these two processes is responsible for these mutations. What we can say is that Nature has safely been employing what you might call a 'cloning' process in plants for millions of years, and that there must be good evolutionary reasons why these mutations are introduced.'

The new results suggest that variation in clones of plants may have different underlying causes from that of variation in clones of animals -- where it is believed that the effect of environmental factors on how animal genes are expressed is more important and no similar high frequencies of mutations have been observed.

Professor Harberd said: 'Whilst our results highlight that cloned plants and animals are very different they may give us insights into how both bacterial and cancer cells replicate themselves, and how mutations arise during these processes which, ultimately, have an impact on human health.'

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Oxford.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/08/110804212931.htm

A Spectacular Spiral in Leo

This picture of the nearby galaxy NGC 3521 was taken using the FORS1 instrument on ESO's Very Large Telescope, at the Paranal Observatory in Chile. The large spiral galaxy lies in the constellation of Leo (The Lion), and is only 35 million light-years distant. This picture was created from exposures taken through three different filters that passed blue light, yellow/green light, and near-infrared light. These are shown in this picture as blue, green, and red, respectively. (Credit: ESO/O. Maliy)

ScienceDaily (Aug. 8, 2011) — This new picture from ESO's Very Large Telescope shows NGC 3521, a spiral galaxy located about 35 million light years away in the constellation of Leo (The Lion). Spanning about 50 000 light-years, this spectacular object has a bright and compact nucleus, surrounded by richly detailed spiral structure.

The most distinctive features of the bright galaxy NGC 3521 are its long spiral arms that are dotted with star-forming regions and interspersed with veins of dust. The arms are rather irregular and patchy, making NGC

3521 a typical example of a flocculent spiral galaxy. These galaxies have "fluffy" spiral arms that contrast with the sweeping arms of grand-design spirals such as the famous Whirlpool galaxy or M 51, discovered by Charles Messier.

NGC 3521 is bright and relatively close-by, and can easily be seen with a small telescope such as the one used by Messier to catalogue a series of hazy and comet-like objects in the 1700s. Strangely, the French astronomer seems to have missed this flocculent spiral even though he identified several other galaxies of similar brightness in the constellation of Leo.

It was only in the year that Messier published the final version of his catalogue, 1784, that another famous astronomer, William Herschel, discovered NGC 3521 early on in his more detailed surveys of the northern skies. Through his larger, 47-cm aperture, telescope, Herschel saw a "bright center surrounded by nebulosity," according to his observation notes.

In this new VLT picture, colourful, yet ill defined, spiral arms replace Herschel's "nebulosity." Older stars dominate the reddish area in the centre while young, hot blue stars permeate the arms further away from the core.

Oleg Maliy, who participated ESO's Hidden Treasures 2010 competition, selected the data from the FORS1 instrument on ESO's VLT at the Paranal Observatory in Chile that were used to create this dramatic image. Exposures taken through three different filters that passed blue light (coloured blue), yellow/green light (coloured green), and near-infrared light (coloured red) have been combined to make this picture. The total exposure times were 300 seconds per filter. Oleg's image of NGC 3521 was a highly ranked entry in the competition, which attracted almost 100 entries.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by European Southern Observatory - ESO.

http://www.sciencedaily.com/releases/2011/08/110810085506.htm

Did Past Climate Change Encourage Tree-Killing Fungi?

Thread-like monilioid hyphae of the living fungus Rhizoctonia solani (left) resemble hyphae of the 250 million-year-old Reduviasporonites. (Credit: Rhizoctonia image courtesy of Lane Tredway, The American Phytopathological Society)

ScienceDaily (Aug. 7, 2011) — The demise of the world's forests some 250 million years ago likely was accelerated by aggressive tree-killing fungi triggered by global climate change, according to a new study by a University of California, Berkeley, scientist and her Dutch and British colleagues.

The researchers do not rule out the possibility that today's changing climate could cause a similar increase in pathogenic soil bacteria that could devastate forests already stressed by a warming climate and pollution.

The study, available online Aug. 5, will be published in the September 2011 print edition of the journal *Geology* of the Geological Society of America.

The death of the forests -- primarily composed of conifers, which are distant relatives of today's pines and firs -- was part of the largest extinction of life on Earth, which occurred when today's continents were part of one supercontinent, Pangaea. The so-called Permian extinction likely was triggered by immense volcanic eruptions in what is now Siberia. The huge amounts of gas and dust thrown into the atmosphere altered global climate, and some 95 percent of marine organisms and 70 percent of land organisms eventually went extinct.

The scientists claim that thread-like or filamentous microfossils commonly preserved in Permian rock are relatives of a group of fungi, Rhizoctonia, that today is known for members that attack and kill plants.

"Modern Rhizoctonia include some of the most ubiquitous plant pathogens, causing root, stem and foliar diseases in a wide variety of plants," said coauthor Cindy Looy, UC Berkeley assistant professor of integrative biology. "Based on patterns of present-day forest decline, it is likely that fungal disease has been an essential accessory in woodland destabilization, accelerating widespread tree mortality during the end-Permian crisis."

The conifer forests, which covered the semi-arid equatorial region of Pangaea, were eventually replaced by lycopods -- four foot-tall relatives of today's diminutive club mosses -- as well as by seed ferns (pteridosperms). The conifers didn't recover for another 4 to 5 million years.

Looy and her colleagues -- Henk Visscher of the Laboratory of Palaeobotany and Palynology at Utrecht University in the Netherlands and Mark Sephton of the Impacts and Astromaterials Research Centre at Imperial College, London -- caution that today's changing climate could also lead to increased activity of pathogenic soil microbes that could accelerate the death of trees already stressed by higher temperatures and drought.

"Pathogenic fungi are important elements of all forest ecosystems," said Visscher. "When an entire forest becomes weakened by environmental stress factors, onslaught of damaging fungal diseases can result in large-scale tissue death and tree mortality."

The researchers dispute the conclusion of other researchers who claim that the thread-like microfossils are the remains of algae. Furthermore, while the researchers previously thought that Reduviasporonites were fungi that took advantage of dying forests, they now believe the fungi actively helped destroy the forests.

"Previously, mass occurrences of Reduviasporonites had been ascribed to wood-rotting fungi living off an excessive abundance of dead wood," said Looy, a paleobotanist who focuses on pollen and spores as keys to understanding past plant communities. "However, the notion that the microfossils represent Rhizoctonia-like resting structures suggest a much more active role for fungi in the ecological crisis:"

The researchers' conclusion comes largely from the fact that they have found living fungi in the genus Rhizoctonia that have a dormant or resting stage during their life cycles in which they look nearly identical to Reduviasporonites.

"One of our problems was that the microfossils didn't resemble the hyphae of known fungi," Looy said. "Buta few years ago, we realized that we were looking in the wrong direction; that we should have been looking at fungal resting structures, not normal hyphae."

Fungi typically spread by means of thread-like hyphae, which can form immense underground networks of mycelia, especially in forests where the fungi live in a symbiotic relationship with tree roots. Each filament is a chain of cells with hard walls made of chitin, the same substance that insects use for their exoskeleton.

When these hyphae branch and intertwine, they may form resting structures known assclerotia. Sclerotia of modern soil-borne fungi such as Rhizoctonia look nearly identical to the disc-shaped structures found among the Reduviasporonites microfossils. Sclerotia are energy storage structures that can help fungi survive extreme conditions.

The team concluded that the loss of trees and the roots that hold soil in place led to severe topsoil erosion, which carried the sclerotia to the sea.

The researchers acknowledge that conifer forests probably suffered from other environmental stresses as a result of the long-term volcanic eruptions, which spewed carbon dioxide and methane into the atmosphere and likely destroyed some of Earth's protective ozone layer. Nevertheless, they wrote in their paper, "… whatever (the) sequence of events that triggered ecosystem destabilization on land, the aggressiveness of soil-borne pathogenic fungi must have been an integral factor involved in Late Permian forest decline worldwide."

The work was funded by Utrecht University, Imperial College London and the University of California, Berkeley.

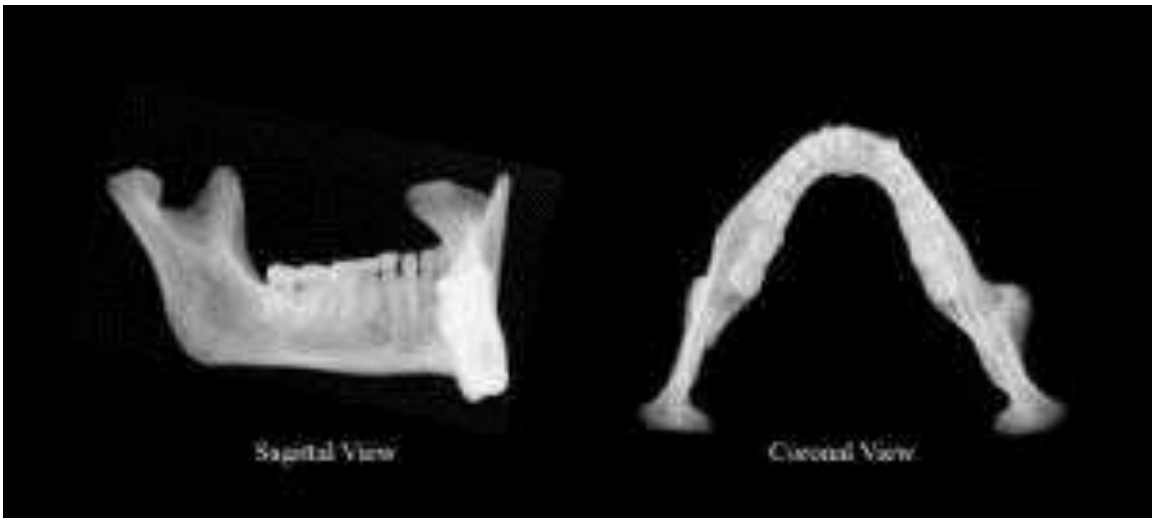
story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of California - Berkeley. The original article was written by Robert Sanders.

Journal Reference:

1. Henk Visscher, Mark A. Sephton, and Cindy V. Looy. Fungal virulence at the time of the end-Permian biosphere crisis? *Geology*, August 5, 2011 DOI: 10.1130/G32178.1

http://www.sciencedaily.com/releases/2011/08/110805163547.htm

What Shapes a Bone? Diet and Genetics Dictate Adult Jaw Shape



This is a radiograph of adult Arikara specimen. (Credit: Johns Hopkins Medicine)

ScienceDaily (Aug. 6, 2011) — Researchers at Johns Hopkins found that use over time and not just genetics informs the structure of jaw bones in human populations. The researchers say these findings may be used to predict the diet of an ancient population, even if little evidence exists in the fossil record. It can also make it easier for scientists to pinpoint the genetic relationship between fossils.

Their results were published online June 23 in the *American Journal of Physical Anthropology*.

"Our research aimed to see how much of the mandible's -- or jaw bone's -- shape is plastic, a response to environmental influences, such as diet, and how much is genetic. We used archaeological jaw bones from two different regions to answer that question," explains Megan Holmes, graduate student at the Johns Hopkins Center for Functional Anatomy and Evolution, and lead author of the paper. "Before we can make inferences about what the shape of a bone tells us, like what environment the individual lived in, who it's related to or what it ate, we have to understand what creates that shape. The idea that function influences the shape of jaw bones is great for the archeological record in terms of discovering the diet of a population, and it's also really useful for reconstructing the fossil record -- finding which fossils are related to which, and how."

The group chose to study the Arikara and Point Hope American Indian populations, since they were genetically isolated from other groups and ate different diets. They investigated bones from the regions dating back to the 1600s and 1700s, times for which the diets are known from other records. The Point Hope population in Alaska ate a "hard" diet that included tough dried meat. They also used their teeth for a variety of nonfood-related tasks, such as stripping leather. The Arikara, from the Dakota area of the United States, ate a softer diet, which consisted of farming supplemented with light hunting.

The researchers precisely measured jaw bones from 63 members of the Point Hope population and 42 individuals from the Arikara population using an X-ray gun as well as calipers, and they used those measurements to extrapolate the proportions of the entire jaw. "The jaw bones were similar in children before they were old enough to start chewing, but different in adulthood, which implies that this divergence is likely a functional result of their diet and the use of their jaw, rather than genetics," says Holmes.

The changes to the jaw bones were explained using a theory drawn from engineering, which directly relates the geometry of a bone to the stresses put on it during use. The team was able to investigate very specific

parts of the jaw bones and relate them to specific dietary habits. In the Point Hope population, for example, they found round, wide jaw bones -- a result of having to exert more force to chew a harder diet. The Arikara, on the other hand, did not show this expansion, which they attributed to the lighter chewing requirement of a softer diet.

"Genetics creates a blueprint of the bone, but a lot of things influence the bone's construction," says Holmes. "Mechanical pressure from muscle stress and strain from day-to-day activities can remodel the bone's surface and internal structure. Knowing how much the shape of a mandible we find is related to diet and how much genetically connects it to fossils found elsewhere can really help us parse out the family tree."

This study was funded by the Johns Hopkins Center of Functional Anatomy and Evolution.

Christopher B. Ruff, Ph.D., also of the Johns Hopkins University School of Medicine's Center of Functional Anatomy and Evolution, was the faculty advisor and co-author of the study.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Johns Hopkins Medical Institutions.

Journal Reference:

1. Megan A. Holmes, Christopher B. Ruff. Dietary effects on development of the human mandibular corpus. *American Journal of Physical Anthropology*, 2011; 145 (4): 615 DOI: 10.1002/ajpa.21554

http://www.sciencedaily.com/releases/2011/08/110805135351.htm

Females Can Place Limits On Evolution of Attractive Features in Males, Research Shows

Female túngara frogs have a limited cognitive ability to recognize increasing elaboration in male mating calls. Fringe-lipped bats that hunt the singing males also have a limited cognitive ability to notice increases in male call complexity. So, the evolution of increasing complexity in male calls is limited by decreased female response rather than increased predation. (Credit: Photo composite by Michael Teague O'Mara. Photos by A. Baugh, K. Lampert and A. Lang.)

ScienceDaily (Aug. 5, 2011) — Female cognitive ability can limit how melodious or handsome males become over evolutionary time, biologists from The University of Texas at Austin, Louisiana State University Health Sciences Center and the Smithsonian Tropical Research Institute have observed.

Males across the animal world have evolved elaborate traits to attract females, from huge peacock tails to complex bird songs and frog calls. But what keeps them from getting more colorful feathers, longer tails, or more melodious songs? Predators, for one. Increased elaboration can draw predators in, placing an enormous cost to males with these sexy traits.

In a new paper appearing this week in *Science*, a group of biologists have shown that females themselves can also limit the evolution of increased elaboration.

Studying *neotropical túngara* frogs, they found that females lose their ability to detect differences in male mating calls as the calls become more elaborate.

"We have shown that the female *túngara* frog brains have evolved to process some kinds of information and not others," says Mike Ryan, professor of integrative biology at The University of Texas at Austin, "and that this limits the evolution of those signals."

Imagine looking at a group of five oranges next to a group of six. At a glance, you would quickly notice that one group has one more orange than the other. Now, imagine looking at a pile of 100 oranges next to a pile of 101. It would be nearly impossible for you to notice the difference in size (one orange) between those two piles at a glance. This is known as Weber's Law, which states that stimuli are compared based on proportional differences rather than absolute differences (one orange in the case above).

In *túngara* frogs, males gather en masse to attract female frogs with a call that is made up of a longer "whine" followed by one or more short "chucks."

Through a series of experiments conducted in Panama, Ryan and his collaborators found that females prefer male calls with the most chucks, but their preference was based on the ratio of the number of chucks. As males elaborate their call by adding more chucks, their relative increase in attractiveness decreases due to a perceptual constraint on the part of females.

Male *túngara* frog calls also attract a predator: the frog eating fringe-lipped bat. To confirm that male song elaboration wasn't limited by these predators, the researchers also studied how the bats respond to additional "chucks" in the male call.

They discovered that hunting bats choose their prey based on chuck number ratio, just as the female frogs do. So, as males elaborate their call by adding chucks, the relative increase in predation risk decreases with each additional chuck.

"What this tells us is that predation risk is unlikely to limit male call evolution," says Karin Akre, lecturer at The University of Texas at Austin. "Instead, it is the females' cognition that limits the evolution of increasing chuck number."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Texas at Austin, via EurekAlert!, a service of AAAS.

Journal Reference:

1. K. L. Akre, H. E. Farris, A. M. Lea, R. A. Page, M. J. Ryan. Signal Perception in Frogs and Bats and the Evolution of Mating Signals. *Science*, 2011; 333 (6043): 751 DOI: 10.1126/science.1205623

http://www.sciencedaily.com/releases/2011/08/110804170039.htm

NASA's Juno Spacecraft Launches to Jupiter

NASA's Juno mission lifts off from Cape Canaveral Air Force Station in Florida. (Credit: NASA)

ScienceDaily (Aug. 5, 2011) — NASA's solar-powered Juno spacecraft lifted off from Cape Canaveral Air Force Station in Florida at 9:25 a.m. PDT (12:25 p.m. EDT), Aug. 5, 2011 to begin a five-year journey to Jupiter.

Juno's detailed study of the largest planet in our solar system will help reveal Jupiter's origin and evolution. As the archetype of giant gas planets, Jupiter can help scientists understand the origin of our solar system and learn more about planetary systems around other stars.

"Today, with the launch of the Juno spacecraft, NASA began a journey to yet another new frontier," NASA Administrator Charles Bolden said. "The future of exploration includes cutting-edge science like this to help us better understand our solar system and an ever-increasing array of challenging destinations."

After Juno's launch aboard an Atlas V rocket, mission controllers now await telemetry from the spacecraft indicating it has achieved its proper orientation, and that its massive solar arrays, the biggest on any NASA deep-space probe, have deployed and are generating power.

"We are on our way, and early indications show we are on our planned trajectory," said Jan Chodas, Juno project manager at NASA's Jet Propulsion Laboratory in Pasadena, Calif. "We will know more about Juno's status in a couple hours after its radios are energized and the signal is acquired by the Deep Space Network antennas at Canberra."

Juno will cover the distance from Earth to the moon (about 250,000 miles or 402,336 kilometers) in less than one day's time. It will take another five years and 1,740 million miles (2,800 million kilometers) to complete the journey to Jupiter. The spacecraft will orbit the planet's poles 33 times and use its collection of eight science instruments to probe beneath the gas giant's obscuring cloud cover to learn more about its origins, structure, atmosphere and magnetosphere, and look for a potential solid planetary core.

With four large moons and many smaller moons, Jupiter forms its own miniature solar system. Its composition resembles that of a star, and if it had been about 80 times more massive, the planet could have become a star instead.

"Jupiter is the Rosetta Stone of our solar system," said Scott Bolton, Juno's principal investigator from the Southwest Research Institute in San Antonio. "It is by far the oldest planet, contains more material than all the other planets, asteroids and comets combined, and carries deep inside it the story of not only the solar system but of us. Juno is going there as our emissary -- to interpret what Jupiter has to say."

Juno's name comes from Greek and Roman mythology. The god Jupiter drew a veil of clouds around himself to hide his mischief, and his wife, the goddess Juno, was able to peer through the clouds and reveal Jupiter's true nature.

The NASA Deep Space Network -- or DSN -- is an international network of antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. The network also supports selected Earth-orbiting missions.

JPL manages the Juno mission for the principal investigator, Scott Bolton, of Southwest Research Institute in San Antonio. The Juno mission is part of the New Frontiers Program managed at NASA's Marshall Space Flight Center in Huntsville, Ala. Lockheed Martin Space Systems, Denver, built the spacecraft. Launch management for the mission is the responsibility of NASA's Launch Services Program at the Kennedy Space Center in Florida. JPL is a division of the California Institute of Technology in Pasadena.

For more information about Juno, visit http://www.nasa.gov/juno and http://missionjuno.swri.edu .

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA/Jet Propulsion Laboratory.

http://www.sciencedaily.com/releases/2011/08/110805132541.htm

Light Shed On South Pole Dinosaurs

This is a cross section of a South Pole dinosaur bone. In the center of the bone marrow cavity are dirt and bone matrix. (Credit: Photo courtesy of Holly Woodward)

ScienceDaily (Aug. 5, 2011) — Dog-sized dinosaurs that lived near the South Pole, sometimes in the dark for months at a time, had bone tissue very similar to dinosaurs that lived everywhere on the planet, according to a doctoral candidate at Montana State University.

That surprising fact falsifies a 13-year-old study and may help explain why dinosaurs were able to dominate the planet for 160 million years, said Holly Woodward, MSU graduate student in the Department of Earth Sciences and co-author of a paper published Aug. 3 in the journal *PLoS ONE.*

"If we were trying to find evidence of dinosaurs doing something much different physiologically, we would expect it to be found in dinosaurs from an extreme environment such as the South Pole," Woodward said. "But based on bone tissues, dinosaurs living within the Antarctic Circle were physiologically similar to dinosaurs living everywhere else.

"This tells us something very interesting; that basically from the very start, early dinosaurs, or even the ancestors of dinosaurs, evolved a physiology that allowed an entire group of animals to successfully exploit a multitude of environmental conditions for millions of years," Woodward said.

Jack Horner, Woodward's adviser and Regents Professor of Paleontology/Curator of Paleontology at MSU's Museum of the Rockies, said Woodward's findings are consistent with other results from the museum's histology lab.

"I think the most important finding is that polar dinosaurs don't seem to be any different than any other dinosaurs in respect to how their bones grew," Horner said. "Dinosaurs have annual growth lines and those that don't have them are simply not yet a year old."

Woodward said she conducted her research after reading a 1998 study about polar dinosaurs. Intrigued by the study, she decided to review the findings and received a National Science Foundation grant that allowed her to travel to Australia last summer, set up a histology laboratory and analyze bones in a rare collection in Australia's Melbourne Museum.

Woodward analyzed the bone tissue of 17 dinosaurs that lived 112 to 100 million years ago during the latter part of the Early Cretaceous Period. All but one of the dinosaurs in her study were plant eaters. All lived in the Antarctic Circle in what is now known as the Australian state of Victoria.

Also participating in the study were the authors of the original study: Anusuya Chinsamy at the University of Cape Town in South Africa, Tom Rich at the Melbourne Museum and Patricia Vickers-Rich at Monash University in Australia.

The three scientists who conducted the original study welcomed her analysis and didn't mind that she falsified their hypothesis, Woodward said. She added that the new study looked at more dinosaur bones than the original study because more bones from the polar dinosaurs were available. Paleontologists have been adding to the collection over the past 25 to 30 years.

The original study looked at the bone microstructure of the polar dinosaurs and concluded that the differences they saw indicated that some dinosaurs survived harsh polar conditions by hibernating, while others evolved in a way that allowed them to be active year-round, Woodward said.

The new study showed that all but the youngest dinosaurs had "Lines of Arrested Growth" or LAGs, Woodward said. Since the hibernation hypothesis was based on the presence or absence of LAGs, the new study falsified the hypothesis.

LAGSs, in a bone cross section, look like tree rings, Woodward said. Like tree rings, they are formed when growth temporarily stops.

"Research on animals living today suggests that LAGs form annually, regardless of latitude or climate," Woodward said. "Like tree rings, LAGs can be counted to age an animal, so that the absence of these marks likely indicates a dinosaur was less than a year old. These marks have also been found in dinosaurs that lived at much lower latitudes having no need to hibernate."

The new study doesn't mean there was nothing unique about polar dinosaurs, but those qualities aren't apparent in bone tissue, Woodward said.

"It is very likely that dinosaurs living in different environments evolved specific adaptations -- either physical or behavioral -- to cope with environmental conditions," she said. "Analysis of bone microstructure can tell us a great deal about growth, but some things just aren't recorded in bone tissue."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Montana State University.

Journal Reference:

1. Holly N. Woodward, Thomas H. Rich, Anusuya Chinsamy, Patricia Vickers-Rich. Growth Dynamics of Australia's Polar Dinosaurs. *PLoS ONE*, 2011; 6 (8): e23339 DOI: 10.1371/journal.pone.0023339

http://www.sciencedaily.com/releases/2011/08/110804170045.htm

Northern Humans Had Bigger Brains, to Cope With the Low Light Levels, Study Finds

Skulls from the 1800s used in the study. (Credit: Copyright University of Oxford)

ScienceDaily (Aug. 5, 2011) — The farther that human populations live from the equator, the bigger their brains, according to a new study by Oxford University. But it turns out that this is not because they are smarter, but because they need bigger vision areas in the brain to cope with the low light levels experienced at high latitudes.

Scientists have found that people living in countries with dull, grey, cloudy skies and long winters have evolved bigger eyes and brains so they can visually process what they see, reports the journal *Biology Letters*.

The researchers measured the eye socket and brain volumes of 55 skulls, dating from the 1800s, from museum collections. The skulls represented 12 different populations from across the globe. The volume of the eye sockets and brain cavities were then plotted against the latitude of the central point of each individual's country of origin. The researchers found that the size of both the brain and the eyes could be directly linked to the latitude of the country from which the individual came.

Lead author Eiluned Pearce, from the Institute of Cognitive and Evolutionary Anthropology in the School of Anthropology, said: 'As you move away from the equator, there's less and less light available, so humans have had to evolve bigger and bigger eyes. Their brains also need to be bigger to deal with the extra visual input. Having bigger brains doesn't mean that higher latitude humans are smarter, it just means they need bigger brains to be able to see well where they live.'

Co-author Professor Robin Dunbar, Director of the Institute of Cognitive and Evolutionary, said: 'Humans have only lived at high latitudes in Europe and Asia for a few tens of thousands of years, yet they seem to have adapted their visual systems surprisingly rapidly to the cloudy skies, dull weather and long winters we experience at these latitudes.'

That the explanation is the need to compensate for low light levels at high latitudes is indicated by the fact that actual visual sharpness measured under natural daylight conditions is constant across latitudes, suggesting that the visual processing system has adapted to ambient light conditions as human populations have moved across the globe.

The study takes into account a number of potentially confounding effects, including the effect of phylogeny (the evolutionary links between different lineages of modern humans), the fact that humans living in the higher latitudes are physically bigger overall, and the possibility that eye socket volume was linked to cold weather (and the need to have more fat around the eyeball by way of insulation).

The skulls used in the study were from the indigenous populations of England, Australia, Canary Islands, China, France, India, Kenya, Micronesia, Scandinavia, Somalia, Uganda and the United States. From measuring the brain cavity, the research suggests that the biggest brains belonged to populations who lived in Scandinavia with the smallest being Micronesians.

This study adds weight to other research that has looked at the links between eye size and light levels. Other studies have already shown that birds with relatively bigger eyes are the first to sing at dawn in low light. The eyeball size across all primates has been found to be associated with when they choose to eat and forage -- with species with the largest eyes being those that are active at night.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Oxford.

Journal Reference:

1. E. Pearce, R. Dunbar. Latitudinal variation in light levels drives human visual system size. *Biology Letters*, 2011; DOI: 10.1098/rsbl.2011.0570

http://www.sciencedaily.com/releases/2011/08/110804214410.htm

Has Sculpture Become Just Another Pretty Face?

By MICHAEL KIMMELMAN

Published:

BERLIN — Sometimes on a whim I stop into the Bode Museum here to commune with a tiny clay sculpture of John the Baptist.

It's in a corner of a nearly always empty room, a bone-white bust, pretty and as androgynous as mid-1970s Berlin-addled David Bowie. The saint's upturned eyes glow in the hard light through tall windows. Attributed to the 15th-century Luccan artist Matteo Civitali, the sculpture is all exquisite ecstasy and languor.

Sometimes it's not the saint I check on but a sculptured portrait in the same room of the banker Filippo Strozzi — stern like a Roman emperor, the face of rectitude and power — by Benedetto da Maiano, Civitali's contemporary. Then I usually climb the stairs to admire Houdon's bust of Gluck, the composer, and ogle a towering pair of craggy German knights, relics of Renaissance pageantry made of painted wood, each taller than the N.B.A. star Dirk Nowitzki.

Mostly, though, I go to the Bode for the silence.

Like a sentry commanding the northern tip of Berlin's Museum Island, its back turned to the busier Pergamon Museum, the Neues Museum, the Altes Museum and the Alte Nationalgalerie, the Bode seems to attract just a few handfuls of visitors a day. Some go there to see the paintings, coins and Byzantine art. The sculpture rooms are mostly abandoned.

Is it me, or do we seem to have a problem with sculpture today? I don't mean contemporary sculpture, whose fashionable stars (see Koons, Murakami et alia) pander to our appetite for spectacle and whatever's new. I don't mean ancient or even non-Western sculpture, either. I mean traditional European sculpture — celebrities like Bernini and Rodin aside — and American sculpture, too: the enormous universe of stuff we come across in churches and parks, at memorials and in museums like the Bode. The stuff Barnett Newman, the Abstract Expressionist painter, notoriously derided as objects we bump into when backing up to look at a painting.

A few minutes' walk from the Bode, the Friedrichswerdersche Kirche, the rebuilt neo-Gothic former church designed by Karl Friedrich Schinkel in the 1830s, houses its own sublime assortment of 19th-century sculpture. It's usually even emptier than the Bode, and it is free to boot. I'll occasionally spend an hour or so there, feeling small and unimportant before the portraits of Kant and the great German archaeologist Johann Winckelmann. Except for the doleful guards, I rarely encounter another living soul.

I grew up with the smells of plaster dust and clay in my mother's sculpture studio on Third Avenue. Making a figure out of stone or metal retains its childlike wonder for me. But sculpture skeptics from Leonardo through Hegel and Diderot have cultivated our prejudice against the medium. "Carib art," is how Baudelaire described sculpture, meaning that even the suavest, most sophisticated works of unearthly virtuosity by Enlightenment paragons like Canova and Thorvaldsen were tainted by the medium's primitive, cultish origins.

Racism notwithstanding, Baudelaire had a point. Sculpture does still bear something of the burden of its commemorative and didactic origins. It's too literal, too direct, too steeped in religious ceremony and too complex for a historically amnesiac culture. We prefer the multicolored distractions of illusionism on flat surfaces, flickering in a movie theater or digitized on our laptops and smartphones, or painted on canvas. The

marketplace ratifies our myopia, making headlines for megamillion-dollar sales of old master and Impressionist pictures but rarely for premodern sculptures.

Critics bow to fashion and a legacy of lazy disdain, largely avoiding the topic — I've done it myself, so I know — and museums only perpetuate the cycle, offering a steady flow of Botticelli, Monet and Rembrandt exhibitions, before which we genuflect like medieval pilgrims praying before sculptured shrines. But sculpture shows that might broaden our horizons, being costly and difficult to mount, are almost rarer than genuine newly discovered Michelangelos.

In an age of special effects, we may also simply no longer know how to feel awe at the sight of sculptured faces by the German genius Tilman Riemenschneider or before a bronze statue by Donatello. We can't see past the raw materiality and subject matter. Never mind that Donatello may have been the greatest creative genius until Picasso; he long ago got lapped in the public's imagination by Madame Tussaud, who has given way to "Avatar" in 3-D and Alexander McQueen's trippy costumed mannequins.

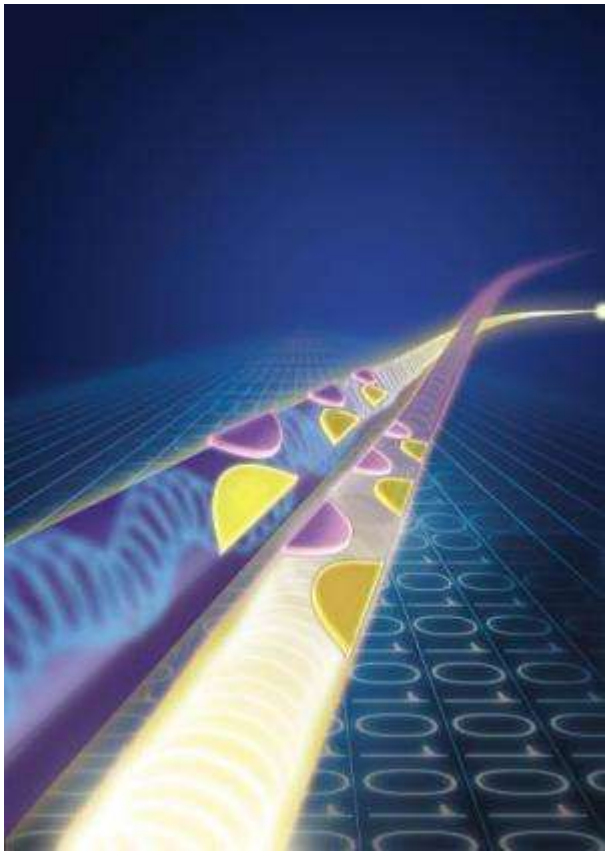
I read the other day that the Metropolitan Museum had decided to stay open late to accommodate the bewildering crowds for its McQueen extravaganza. Mass hysteria is how a friend described it to me. It clearly became the height of fashion for people to stand in the endless line, if only to have been able to say that they stood in the endless line. How many of those people, I asked myself, stopped to look at any of the Met's sculptures while they were there, or ever had?

How wonderful, I also thought.

I have the Bode to myself.

http://www.nytimes.com/interactive/2011/08/09/arts/design/kimmelman-postcards-sculpt.html?ref=design

Engineers Solve Longstanding Problem in Photonic Chip Technology: Findings Help Pave Way for Next Generation of Computer Chips



Caltech engineers have developed a new way to isolate light on a photonic chip, allowing light to travel in only one direction. This finding can lead to the next generation of computer-chip technology: photonic chips that allow for faster computers and less data loss. (Credit: Caltech/Liang Feng)

ScienceDaily (Aug. 5, 2011) — Stretching for thousands of miles beneath oceans, optical fibers now connect every continent except for Antarctica. With less data loss and higher bandwidth, optical-fiber technology allows information to zip around the world, bringing pictures, video, and other data from every corner of the globe to your computer in a split second. But although optical fibers are increasingly replacing copper wires, carrying information via photons instead of electrons, today's computer technology still relies on electronic chips.

Now, researchers led by engineers at the California Institute of Technology (Caltech) are paving the way for the next generation of computer-chip technology: photonic chips. With integrated circuits that use light instead of electricity, photonic chips will allow for faster computers and less data loss when connected to the global fiber-optic network.

"We want to take everything on an electronic chip and reproduce it on a photonic chip," says Liang Feng, a postdoctoral scholar in electrical engineering and the lead author on a paper to be published in the August 5 issue of the journal *Science*. Feng is part of Caltech's nanofabrication group, led by Axel Scherer, Bernard A. Neches Professor of Electrical Engineering, Applied Physics, and Physics, and co-director of the Kavli Nanoscience Institute at Caltech.

In that paper, the researchers describe a new technique to isolate light signals on a silicon chip, solving a longstanding problem in engineering photonic chips.

An isolated light signal can only travel in one direction. If light weren't isolated, signals sent and received between different components on a photonic circuit could interfere with one another, causing the chip to become unstable. In an electrical circuit, a device called a diode isolates electrical signals by allowing current to travel in one direction but not the other. The goal, then, is to create the photonic analog of a diode, a device called an optical isolator. "This is something scientists have been pursuing for 20 years," Feng says.

Normally, a light beam has exactly the same properties when it moves forward as when it's reflected backward. "If you can see me, then I can see you," he says. In order to isolate light, its properties need to somehow change when going in the opposite direction. An optical isolator can then block light that has these changed properties, which allows light signals to travel only in one direction between devices on a chip.

"We want to build something where you can see me, but I can't see you," Feng explains. "That means there's no signal from your side to me. The device on my side is isolated; it won't be affected by my surroundings, so the functionality of my device will be stable."

To isolate light, Feng and his colleagues designed a new type of optical waveguide, a 0.8-micron-wide silicon device that channels light. The waveguide allows light to go in one direction but changes the mode of the light when it travels in the opposite direction.

A light wave's mode corresponds to the pattern of the electromagnetic field lines that make up the wave. In the researchers' new waveguide, the light travels in a symmetric mode in one direction, but changes to an asymmetric mode in the other. Because different light modes can't interact with one another, the two beams of light thus pass through each other.

Previously, there were two main ways to achieve this kind of optical isolation. The first way -- developed almost a century ago -- is to use a magnetic field. The magnetic field changes the polarization of light -- the orientation of the light's electric-field lines -- when it travels in the opposite direction, so that the light going one way can't interfere with the light going the other way. "The problem is, you can't put a large magnetic field next to a computer," Feng says. "It's not healthy."

The second conventional method requires so-called nonlinear optical materials, which change light's frequency rather than its polarization. This technique was developed about 50 years ago, but is problematic because silicon, the material that's the basis for the integrated circuit, is a linear material. If computers were to use optical isolators made out of nonlinear materials, silicon would have to be replaced, which would require revamping all of computer technology. But with their new silicon waveguides, the researchers have become the first to isolate light with a linear material.

Although this work is just a proof-of-principle experiment, the researchers are already building an optical isolator that can be integrated onto a silicon chip. An optical isolator is essential for building the integrated, nanoscale photonic devices and components that will enable future integrated information systems on a chip. Current, state-of-the-art photonic chips operate at 10 gigabits per second (Gbps) -- hundreds of times the data-transfer rates of today's personal computers -- with the next generation expected to soon hit 40 Gbps. But without built-in optical isolators, those chips are much simpler than their electronic counterparts and are not yet ready for the market. Optical isolators like those based on the researchers' designs will therefore be crucial for commercially viable photonic chips.

In addition to Feng and Scherer, the other authors on the *Science* paper, "Non-reciprocal light propagation in a silicon photonic circuit," are Jingqing Huang, a Caltech graduate student; Maurice Ayache of UC San Diego

and Yeshaiahu Fainman, Cymer Professor in Advanced Optical Technologies at UC San Diego; and Ye-Long Xu, Ming-Hui Lu, and Yan-Feng Chen of the Nanjing National Laboratory of Microstructures in China. This research was done as part of the Center for Integrated Access Networks (CIAN), one of the National Science Foundation's Engineering Research Centers. Fainman is also the deputy director of CIAN. Funding was provided by the National Science Foundation, and the Defense Advanced Research Projects Agency.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by California Institute of Technology. The original article was written by Marcus Woo.

Journal Reference:

1. Liang Feng, Maurice Ayache, Jingqing Huang, Ye-Long Xu, Ming-Hui Lu, Yan-Feng Chen, Yeshaiahu Fainman, Axel Scherer. Nonreciprocal Light Propagation in a Silicon Photonic Circuit. *Science*, August 2011: Vol. 333 no. 6043 pp. 729-733 DOI: 10.1126/science.1206038

http://www.sciencedaily.com/releases/2011/08/110804141714.htm

All-Natural Terraces

By AMANDA SCHMIDT

Amanda SchmidtA view from the road looking over Panya Village toward Asano, the archaeology site, and Jianpan Village.

Amanda Schmidt, an assistant professor of geology at Oberlin College, writes from Sichuan Province, China. She is studying the relative natural hazards of some places where people choose to live.

Friday, Aug. 5

I want to answer a question that came up in comments a few days ago: How do we know that the terraces weren't made by people? We are relying on two lines of evidence. One is ethnographic research. A team of social scientists conducted interviews with local elders in 2007 and asked questions about the terraces. Although local people do maintain terraces in what they call black soil, the ones in green soil (loess) are totally natural; they don't do any maintenance to them, nor did they build them. In fact, one local woman remembers her uncle pushing soil from one terrace down to lower ones, the opposite of trying to keep them in place. In other places with dry terraces, like Nepal, local people have to do extensive maintenance on the terraces annually.

The other line of evidence we have that the terraces are not made by humans is that the stratigraphy in terrace scarps correlates well from one terrace to the next. In other words, you can look at one face and see loess topped by a paleosol and then covered in flow deposits. You can then find the exact same stratigraphy in a series of three or four terraces. This suggests that they all used to be on the same level surface. We previously believed that they are a natural result of human occupation but now believe that you may not need people at all to form them.

Amanda SchmidtThis would have been a lovely place to live, except that it is kind of a trek for water. Distance to water was traditionally a relatively minor concern for the local people; many of the old, and now abandoned, villages are some distance from water.

Amanda Schmidt

Our working hypothesis for terrace formation is that loess blew into the area from somewhere (we are working on this) during the last glacial maximum (about 15,000 years ago) and was deposited everywhere. Because loess fails at relatively low angles, it stuck to only the lowest-angle slopes — mainly landslide deposits or weak bedrock. On the wetter and cooler slopes (mainly north-facing), it slid off quickly. On the warmer and drier slopes (mainly south-facing), it stuck around and piled as thick as seven meters. Then, when there was an earthquake or big rainstorm, the loess couldn't hold together and completely failed; the crummy rock may have failed as well. Under these conditions, loess can flow like a liquid; it would have flowed down and incorporated bits of bedrock into the flow. When it stopped moving and set up, it became harder. Then, much later on, this flow deposit failed in blocks that slumped to form the terraces. This may have been related to deforestation when the Tibetans moved in 250 or so years ago. The slumping has to postdate the flows

because of the stratigraphy lining up in multiple terrace faces. So, we can date the formation of the terraces to be no older than the youngest flows. Dating the flows may tell us about the frequency of earthquakes or really big rainstorms/wet monsoons as well.

That said, the 2008 Wenchuan earthquake doesn't seem to have caused any major landsliding or slumping in the terraces. The road is falling apart, but it isn't clear if the slumping road would have happened anyway because the bedrock is so weak.

Amanda SchmidtXenna slowly makes her way up a trail packed into a landslide deposit. I believe this landslide started in 2007, although I am not positive. It is still active and is one of the numerous things threatening the road up to the uppermost village.

Another wrinkle came from a Chinese professor who has worked here. When our University of Washington colleague met with some of our Chinese collaborators in Chengdu yesterday, he floated our ideas about a combination of loess flows and block faulting forming the local terraces. One of the professors told our colleague that the loess is original deposition and that the presence of stones in loess is quite normal; they have found ages in the archaeological site that decrease linearly with depth. I have to admit that I just don't see how you can get bits of local bedrock in your windblown dust deposit unless you have something mixing it with broken-up bedrock. For the stones to be supported by the loess, you really need some other process besides aeolian transport. I have no explanation for the linear decrease in ages with depth; I am still puzzling over it and would like to see the data.

Xenna GohSampling the 7-meter-tall loess scarp at 6.5 meters without a ladder.

After waking up to this major wrinkle in our story but fueled by a splurge on a Western-style breakfast in a local hostel, Xenna and I set out to finish our sampling in Heye Valley — the one with the archaeological site. We are trying to get a bunch of samples to show correlations among various terrace scarps. Yesterday was our last day on the terraces below the village; today we needed to get to terraces above the village and some others up above the road in a different direction. We found some pretty neat stuff: a few places with heaps of charcoal and good potential for radiocarbon dates; old tree roots (I think) sticking out of the loess, which could be evidence of the area previously being forested, as they were quite big and can be dated as well; a tall cliff of loess (no rocks!) with a paleosol in the middle. We collected lots of samples, including one at 6.5 meters on the 7-meter cliff — to get this one I lay down on the top and sampled as far down as my arms could reach.

Tomorrow Xenna gets a rest day to play tourist in the park; I go back to Zharu to look at the river sand in the strange deposits (another wrinkly story that I will tell you about another time).

http://scientistatwork.blogs.nytimes.com/2011/08/10/all-natural-terraces/?ref=science

Taller Women Are at Increased Risk of a Wide Range of Cancers, Research Suggests

A new study found that in women the risk of cancer rises by about 16% for every 10cm (4 inches) increase in height. (Credit: © Gina Smith / Fotolia)

ScienceDaily (Aug. 5, 2011) — Taller people are at increased risk of a wide range of cancers, according to new research led by Oxford University.

The study found that in women the risk of cancer rises by about 16% for every 10cm (4 inches) increase in height. Previous studies have shown a link between height and cancer risk, but this research extends the findings to more cancers and for women with differing lifestyles and economic backgrounds.

A report of the research is published Online First in *The Lancet Oncology*.

'We showed that the link between greater height and increased total cancer risk is similar across many different populations from Asia, Australasia, Europe, and North America,' said Dr Jane Green, lead author of the study, who is based at the Cancer Epidemiology Unit at Oxford University.

'The link between height and cancer risk seems to be common to many different types of cancer and in different people; suggesting that there may be a basic common mechanism, perhaps acting early in peoples' lives, when they are growing.'

To investigate the impact of height on overall and site-specific cancer risk, Dr Green and colleagues assessed the association between height, other factors relevant for cancer, and cancer incidence, in the Cancer Research UK-funded Million Women Study, which included 1.3 million middle-aged women in the UK enrolled between 1996 and 2001. During an average follow-up time of about 10 years, 97,000 cases of cancer were identified.

The risk of total cancer increased with increasing height, as did the risk of many different types of cancer, including cancers of the breast, ovary, womb, bowel, leukemia and malignant melanoma. The authors also conducted a meta-analysis combining their results with those from ten previous studies.

Although it is still not clear how height increases cancer risk, it has been suggested that environmental influences including diet and infections in childhood, as well as growth hormone levels, might be involved.

The results suggest that increases in the height of populations over the course of the 20th century might explain some of the changes in cancer incidence over time.

Dr Green said: 'Of course people cannot change their height. Being taller has been linked to a lower risk of other conditions, such as heart disease. The importance of our findings is that they may help us to understand how cancers develop.'

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Oxford.

Journal Reference:

1. Jane Green, Benjamin J Cairns, Delphine Casabonne, F Lucy Wright, Gillian Reeves, Valerie Beral. Height and cancer incidence in the Million Women Study: prospective cohort, and meta-analysis of prospective studies of height and total cancer risk. *The Lancet Oncology*, 2011; 12 (8): 785 DOI: 10.1016/S1470-2045(11)70154-1

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Large Variations in Arctic Sea Ice: Polar Ice Much Less Stable Than Previously Thought, Study Finds

University of Copenhagen researchers surveyed North Greenland beaches to find evidence of fluctuations in the North Pole ice cover over time. (Credit: Svend Funder/University of Copenhagen)

ScienceDaily (Aug. 4, 2011) — For the last 10,000 years, summer sea ice in the Arctic Ocean has been far from constant. For several thousand years, there was much less sea ice in The Arctic Ocean -- probably less than half of current amounts. This is indicated by new findings by the Danish National Research Foundation for Geogenetics at the University of Copenhagen. The results of the study will be published in the journal *Science*.

Sea ice comes and goes without leaving a record. For this reason, our knowledge about its variations and extent was limited before we had satellite surveillance or observations from airplanes and ships. But now researchers at the Danish National Research Foundation for Geogenetics at the Natural History Museum of Denmark (University of Copenhagen) have developed a method by which it is possible to measure the variations in the ice several millennia back in time.

The results are based on material gathered along the coast of northern Greenland, which scientists expect will be the final place summer ice will survive, if global temperatures continue to rise.

This means that the results from northern Greenland also indicate what the conditions are like in the ocean.

Less ice than today

Team leader Svend Funder, and two other team members and co-authors of the *Science* article, Eske Willerslev and Kurt Kjær, are all associated with the Danish Research Foundation at the University of Copenhagen.

Regarding the research results, Funder says, "Our studies show that there have been large fluctuations in the amount of summer sea ice during the last 10,000 years. During the so-called Holocene Climate Optimum, from approximately 8000 to 5000 years ago, when the temperatures were somewhat warmer than today, there was significantly less sea ice in the Arctic Ocean, probably less than 50% of the summer 2007 coverage, which was absolutely lowest on record. Our studies also show that when the ice disappears in one area, it may accumulate in another. We have discovered this by comparing our results with observations from northern Canada. While the amount of sea ice decreased in northern Greenland, it increased in Canada. This is probably due to changes in the prevailing wind systems. This factor has not been sufficiently taken into account when forecasting the imminent disappearance of sea ice in the Arctic Ocean."

Driftwood unlocks mystery

In order to reach their surprising conclusions, Funder and the rest of the team organised several expeditions to Peary Land in northern Greenland. Named after American Polar explorer Robert E. Peary, the region is an inhospitable and rarely visited area, where summer blizzards are not uncommon.

" Our key to the mystery of the extent of sea ice during earlier epochs lies in the driftwood we found along the coast. One might think that it had floated across sea, but such a journey takes several years, and driftwood would not be able to stay afloat for that long. The driftwood is from the outset embedded in sea ice, and reaches the north Greenland coast along with it. The amount of driftwood therefore indicates how much multiyear sea ice there was in the ocean back then. And this is precisely the type of ice that is in danger of disappearing today," Funder says.

After the expeditions had been completed, the team needed to study the wood they had collected: wood types had to be determined and it had to be carbon-14 dated. The driftwood originated near the great rivers of present-day North America and Siberia. The wood types were almost entirely spruce, which is widespread in the Boreal forest of North America, and larch, which is dominates the Siberian taiga. The different wood types therefore are evidence of changing travel routes and altered current and wind conditions in the ocean.

Beach ridges and wave breaking

The team also examined the beach ridges along the coast. Today, perennial ice prevents any sort of beach from forming along the coasts of northern Greenland. But this had not always been the case. Behind the present shore long rows of beach ridges show that at one time waves could break onto the beach unhindered by sea ice. The beach ridges were mapped for 500 kilometres along the coast, and carbon-14 dating has shown that during the warm period from about 8000 until 4000 years ago, there was more open water and less coastal ice than today.

Point of no return

"Our studies show that there are great natural variations in the amount of Arctic sea ice. The bad news is that there is a clear connection between temperature and the amount of sea ice. And there is no doubt that continued global warming will lead to a reduction in the amount of summer sea ice in the Arctic Ocean. The good news is that even with a reduction to less than 50% of the current amount of sea ice the ice will not reach a point of no return: a level where the ice no longer can regenerate itself even if the climate was to return to cooler temperatures. Finally, our studies show that the changes to a large degree are caused by the

effect that temperature has on the prevailing wind systems. This has not been sufficiently taken into account when forecasting the imminent disappearance of the ice, as often portrayed in the media," Funder says.

Research could also benefit polar bears

In addition to giving us a better understanding of what the climate in northern Greenland was like thousands of years ago, it could also reveal how polar bears fared in warmer climate. The team plans to use DNA in fossil polar bear bones to study polar bear population levels during the Holocene Climate Optimum.

The team's findings are to be published in the journal *Science*.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Copenhagen.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/08/110804141706.htm

Fossils of Forest Rodents Found in Highland Desert

Two new rodent fossils were discovered in the arid highlands of southern Bolivia by researchers from Case Western Reserve University School of Medicine and Universidad Autónoma Tomás Frías. Mesoprocta hypsodus, right, is a relative of agoutis and acouchis. Quebradahondomys potosiensis, was a spiny rat, related to extant spiny rats, chinchillas and guinea pigs. Scale bar equals 10 cm. (Credit: Images by Velizar Simeonovski in collaboration with Darin A. Croft.)

ScienceDaily (Aug. 4, 2011) — Two new rodent fossils were discovered in the arid highlands of southern Bolivia by researchers from Case Western Reserve University School of Medicine and Universidad Autónoma Tomás Frías.

The larger of the two rodents, named *Mesoprocta hypsodus*, probably looked something like a guinea pig on stilts, said Darin Croft, an anatomy professor at Case Western Reserve. The smaller, *Quebradahondomys potosiensis*, was a spiny rat.

An online article in the *Journal of Mammalian Evolution* describes the new species, a possible third, and two known species that are new inhabitants to that location.

"The two new species are pretty rare," said Croft. Various teams have been working the Bolivian site, called Quebrada Honda, on and off since the late 1970s. Croft's team has been working there for the past five years and has identified only one fossilized piece of jawbone from each animal.

Croft has been working this remote area, about 12,000 feet above sea level, as well as largely understudied areas in the mountains of northern and central Chile, for 14 years. The research sites are among the highest in the Western Hemisphere.

He and his colleagues have found and documented remains of more than two-dozen new species of mammals, ranging from mouse-sized marsupials to giant armadillos and hoofed, sheep-sized grazers in that time.

Prior research using radiometric and paleomagnetic dating techniques puts the age of the fossils at Quebrada Honda in the range of 12.5 to 13 million years ago.

Though the finds were limited to one fossil each, the teeth provide the telltale features needed to determine their kin and identify them as unique.

Mesoprocta hypsodus is related to agoutis and acouchis, two types of current and common rodents found from Costa Rica to Brazil. Tall, complex teeth are typical of these rodents, which are known for their flatish face, long legs and quickness.

Based on the dimensions of the jawbone and teeth, Croft estimates the extinct rodent was about 18 to 20 inches long, 8 inches to a foot at the shoulder and weighed 8 to 10 pounds.

Croft said that although it probably ate fruits and nuts and spent much of its time foraging among the trees, like its modern relatives, its durable teeth indicate that it may also have ventured into more open areas. Forested habitats no longer exist in the Quebrada Honda area.

Quebradahondomys potosiensis is a rat-sized relative of extant spiny rats, which are mostly tree-dwelling relatives of guinea pigs and chinchillas that have spiny coats and tails that easily break off to help them escape from predators. Currently, spiny rats are found throughout Central America and most of South America.

The molar teeth, which are shaped like a "3" or an "E," are typical of a particular subgroup of spiny rats and indicate the extinct rodent fed on a leafy diet. The researchers say it was at least partially arboreal and may have been living in the same trees among which *Mesoprocta hypsodus* foraged on the ground.

In addition to the two new species above, Croft's group found a number of fossils from the genus Acarechimys.

The remains indicate the animal was about hamster-sized, lived in rocky or bushy environs and fed on leaves and seeds.

Fossils from the genus have been found from Colombia to the southern tip of Argentina, but close analysis is needed to break them down into species. The researchers hope to work with others to define species found.

The most common fossils at the site are from relatives of chinchillas, all of the genus Prolagostomus. They were found in such high numbers that the researchers believe the animals were highly social and, like some of their current relatives, lived in communities much as prairie dogs do today.

Again, closer analysis of known fossils from here and other locations is needed to determine species. Studies of variation in modern relatives will also aid these studies.

Lastly, the investigators found fossils of *Guiomys unica*, a relative of the guinea pig. The species, estimated to be about the size of a large rabbit but proportioned like a cat, was previously found only in the Patagonia region of Argentina, well over 1,000 miles away.

The animal was likely a grass and leaf eater that frequented both open and more sheltered habitats, the researchers said.

The group is continuing to analyze other fossils it has found in this and other Bolivian sites. They plan to return to the field next year to continue searching for fossils and a clearer picture of the past.

"We're a step closer to pulling the whole fauna together," Croft said. "I fully expect we'll get some more new stuff in the next few years."

The research is funded by the National Geographic Society and the National Science Foundation.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Case Western Reserve University, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Darin A. Croft, Jennifer M. H. Chick, Federico Anaya. New Middle Miocene Caviomorph Rodents from Quebrada Honda, Bolivia. *Journal of Mammalian Evolution*, 2011; DOI: 10.1007/s10914-011-9164-z

http://www.sciencedaily.com/releases/2011/08/110804105854.htm

First Opal-Like Crystals Discovered in Meteorite

The Tagish Lake meteorite, which fell to Earth in Canada in 2000, contains unusual opal-like crystals. (Credit: NASA)

ScienceDaily (Aug. 4, 2011) — Scientists have found opal-like crystals in the Tagish Lake meteorite, which fell to Earth in Canada in 2000. This is the first extraterrestrial discovery of these unusual crystals, which may have formed in the primordial cloud of dust that produced the sun and planets of our solar system 4.6 billion years ago, according to a report in the *Journal of the American Chemical Society*.

Katsuo Tsukamoto and colleagues say that colloidal crystals such as opals, which form as an orderly array of particles, are of great interest to for their potential use in new electronics and optical devices. Surprisingly, the crystals in the meteorite are composed of magnetite, which scientists thought could not assemble into such a crystal because magnetic attractions might pack the atoms together too tightly. "We believe that, if synthesized, magnetite colloidal crystals have promising potential as a novel functional material," the article notes.

The formation of colloidal crystals in the meteorite implies that several conditions must have existed when they formed. "First, a certain amount of solution water must have been present in the meteorite to disperse the colloidal particles," the report explains. "The solution water must have been confined in small voids, in which colloidal crystallization takes place. These conditions, along with evidence from similar meteorites, suggest that the crystals may have formed 4.6 billion years ago."

The authors acknowledge funding from the Japan Society for the Promotion of Science, the Tohoku University Global COE Program, and the Center for Interdisciplinary Research Tohoku University.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by American Chemical Society.

Journal Reference:

1. Jun Nozawa, Katsuo Tsukamoto, Willem van Enckevort, Tomoki Nakamura, Yuki Kimura, Hitoshi Miura, Hisao Satoh, Ken Nagashima, Makoto Konoto. Magnetite 3D Colloidal Crystals Formed in the Early Solar System 4.6 Billion Years Ago. *Journal of the American Chemical Society*, 2011; 133 (23): 8782 DOI: 10.1021/ja2005708

http://www.sciencedaily.com/releases/2011/08/110803102846.htm

Water Flowing On Mars, NASA Spacecraft Data Suggest

Warm-Season Flows on Slope in Newton Crater: This series of images shows warm-season features that might be evidence of salty liquid water active on Mars today. (Credit: NASA/JPL-Caltech/Univ. of Arizona)

ScienceDaily (Aug. 4, 2011) — Observations from NASA's Mars Reconnaissance Orbiter have revealed possible flowing water during the warmest months on Mars.

"NASA's Mars Exploration Program keeps bringing us closer to determining whether the Red Planet could harbor life in some form," NASA Administrator Charles Bolden said, "and it reaffirms Mars as an important future destination for human exploration."

Dark, finger-like features appear and extend down some Martian slopes during late spring through summer, fade in winter, and return during the next spring. Repeated observations have tracked the seasonal changes in these recurring features on several steep slopes in the middle latitudes of Mars' southern hemisphere.

"The best explanation for these observations so far is the flow of briny water," said Alfred McEwen of the University of Arizona, Tucson. McEwen is the principal investigator for the orbiter's High Resolution Imaging Science Experiment (HiRISE) and lead author of a report about the recurring flows published in the journal *Science*.

Some aspects of the observations still puzzle researchers, but flows of liquid brine fit the features' characteristics better than alternate hypotheses. Saltiness lowers the freezing temperature of water. Sites with active flows get warm enough, even in the shallow subsurface, to sustain liquid water that is about as salty as Earth's oceans, while pure water would freeze at the observed temperatures.

"These dark lineations are different from other types of features on Martian slopes," said Mars Reconnaissance Orbiter Project Scientist Richard Zurek of NASA's Jet Propulsion Laboratory in Pasadena, Calif. "Repeated observations show they extend ever farther downhill with time during the warm season."

The features imaged are only about 0.5 to 5 yards or meters wide, with lengths up to hundreds of yards. The width is much narrower than previously reported gullies on Martian slopes. However, some of those locations display more than 1,000 individual flows. Also, while gullies are abundant on cold, pole-facing slopes, these dark flows are on warmer, equator-facing slopes.

The images show flows lengthen and darken on rocky equator-facing slopes from late spring to early fall. The seasonality, latitude distribution and brightness changes suggest a volatile material is involved, but there is no

direct detection of one. The settings are too warm for carbon-dioxide frost and, at some sites, too cold for pure water. This suggests the action of brines, which have lower freezing points. Salt deposits over much of Mars indicate brines were abundant in Mars' past. These recent observations suggest brines still may form near the surface today in limited times and places.

When researchers checked flow-marked slopes with the orbiter's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), no sign of water appeared. The features may quickly dry on the surface or could be shallow subsurface flows.

"The flows are not dark because of being wet," McEwen said. "They are dark for some other reason."

A flow initiated by briny water could rearrange grains or change surface roughness in a way that darkens the appearance. How the features brighten again when temperatures drop is harder to explain.

"It's a mystery now, but I think it's a solvable mystery with further observations and laboratory experiments," McEwen said.

These results are the closest scientists have come to finding evidence of liquid water on the planet's surface today. Frozen water, however has been detected near the surface in many middle to high-latitude regions. Fresh-looking gullies suggest slope movements in geologically recent times, perhaps aided by water. Purported droplets of brine also appeared on struts of the Phoenix Mars Lander. If further study of the recurring dark flows supports evidence of brines, these could be the first known Martian locations with liquid water.

The Mars Reconnaissance Orbiter is managed by JPL for NASA's Science Mission Directorate in Washington. The University of Arizona's Lunar and Planetary Laboratory operates HiRISE. The camera was built by Ball Aerospace & Technologies Corp. in Boulder, Colo. Johns Hopkins University Applied Physics Laboratory in Laurel, Md., provided and operates CRISM. JPL is a division of the California Institute of Technology in Pasadena.

For more information about the Mars Reconnaissance Orbiter, visit: http://www.nasa.gov/mro and http://marsprogram.jpl.nasa.gov/mro/ .

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA/Jet Propulsion Laboratory.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/08/110804142118.htm

DNA Strands That Select Nanotubes Are First Step to a Practical 'Quantum Wire'

Wrapped up in their work: this molecular model shows a single-strand DNA molecule (yellow ribbon) coiled around an "armchair" carbon nanotube. (Credit: Roxbury, Jagota/NIST)

ScienceDaily (Aug. 4, 2011) — DNA, a molecule famous for storing the genetic blueprints for all living things, can do other things as well. In a new paper, researchers at the National Institute of Standards and Technology (NIST) describe how tailored single strands of DNA can be used to purify the highly desired "armchair" form of carbon nanotubes. Armchair-form single wall carbon nanotubes are needed to make "quantum wires" for low-loss, long distance electricity transmission and wiring.

Single-wall carbon nanotubes are usually about a nanometer in diameter, but they can be millions of nanometers in length. It's as if you took a one-atom-thick sheet of carbon atoms, arranged in a hexagonal pattern, and curled it into a cylinder, like rolling up a piece of chicken wire. If you've tried the latter, you know that there are many possibilities, depending on how carefully you match up the edges, from neat, perfectly matched rows of hexagons ringing the cylinder, to rows that wrap in spirals at various angles -- "chiralities" in chemist-speak.

Chirality plays an important role in nanotube properties. Most behave like semiconductors, but a few are metals. One special chiral form -- the so-called "armchair carbon nanotube"* -- behaves like a pure metal and is the ideal quantum wire, according to NIST researcher Xiaomin Tu.

Armchair carbon nanotubes could revolutionize electric power systems, large and small, Tu says. Wires made from them are predicted to conduct electricity 10 times better than copper, with far less loss, at a sixth the weight. But researchers face two obstacles: producing totally pure starting samples of armchair nanotubes, and "cloning" them for mass production. The first challenge, as the authors note, has been "an elusive goal."

Separating one particular chirality of nanotube from all others starts with coating them to get them to disperse in solution, as, left to themselves, they'll clump together in a dark mass. A variety of materials have been used as dispersants, including polymers, proteins and DNA. The NIST trick is to select a DNA strand that has a particular affinity for the desired type of nanotube. In earlier work, team leader Ming Zheng and colleagues demonstrated DNA strands that could select for one of the semiconductor forms of carbon nanotubes, an easier target. In this new paper, the group describes how they methodically stepped through simple mutations of the semiconductor-friendly DNA to "evolve" a pattern that preferred the metallic armchair nanotubes instead.

"We believe that what happens is that, with the right nanotube, the DNA wraps helically around the tube," explains Constantine Khripin, "and the DNA nucleotide bases can connect with each other in a way similar to how they bond in double-stranded DNA." According to Zheng, "The DNA forms this tight barrel around the nanotube. I love this idea because it's kind of a lock and key. The armchair nanotube is a key that fits inside this DNA structure -- you have this kind of molecular recognition."

Once the target nanotubes are enveloped with the DNA, standard chemistry techniques such as chromatography can be used to separate them from the mix with high efficiency.

"Now that we have these pure nanotube samples," says team member Angela Hight Walker, "we can probe the underlying physics of these materials to further understand their unique properties. As an example, some optical features once thought to be indicative of metallic carbon nanotubes are not present in these armchair samples."

* From the distinctive shape of the edge of the cylinder.

story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by National Institute of Standards and Technology (NIST).

Journal References:

1. Xiaomin Tu, Angela R. Hight Walker, Constantine Y. Khripin, Ming Zheng. Evolution of DNA Sequences Toward Recognition of Metallic Armchair Carbon Nanotubes. *Journal of the American Chemical Society*, 2011; : 110728080027017 DOI: 10.1021/ja205407q
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http://www.sciencedaily.com/releases/2011/08/110803102903.htm

Ninety-Six Star Clusters Discovered Hidden Behind Dust of Milky Way

Using data from the VISTA infrared survey telescope at ESO's Paranal Observatory, an international team of astronomers has discovered 96 new open clusters hidden by the dust in the Milky Way. Thirty of these clusters are shown in this mosaic. These tiny and faint objects were invisible to previous surveys, but they could not escape the sensitive infrared detectors of the world's largest survey telescope, which can peer through the dust. This is the first time so many faint and small clusters have been found at once. The images are made using infrared light in the following bands: J (shown in blue), H (shown in green), and Ks (shown in red). (Credit: ESO/J. Borissova)

ScienceDaily (Aug. 4, 2011) — Using data from the VISTA infrared survey telescope at the European Southern Observatory's Paranal Observatory, an international team of astronomers has discovered 96 new open star clusters hidden by the dust in the Milky Way. These tiny and faint objects were invisible to previous surveys, but they could not escape the sensitive infrared detectors of the world's largest survey telescope, which can peer through the dust. This is the first time so many faint and small clusters have been found at once.

This result comes just one year after the start of the VISTA Variables in the Via Lactea programme (VVV)*, one of the six public surveys on the new telescope. The results will appear in the journal *Astronomy & Astrophysics*.

"This discovery highlights the potential of VISTA and the VVV survey for finding star clusters, especially those hiding in dusty star-forming regions in the Milky Way's disc. VVV goes much deeper than other surveys," says Jura Borissova, lead author of the study.

The majority of stars with more than half of the mass of our Sun form in groups, called open clusters. These clusters are the building blocks of galaxies and vital for the formation and evolution of galaxies such as our own. However, stellar clusters form in very dusty regions that diffuse and absorb most of the visible light that the young stars emit, making them invisible to most sky surveys, but not to the 4.1-m infrared VISTA telescope.

"In order to trace the youngest star cluster formation we concentrated our search towards known star-forming areas. In regions that looked empty in previous visible-light surveys, the sensitive VISTA infrared detectors uncovered many new objects," adds Dante Minniti, lead scientist of the VVV survey.

By using carefully tuned computer software, the team was able to remove the foreground stars appearing in front of each cluster in order to count the genuine cluster members. Afterwards, they made visual inspections of the images to measure the cluster sizes, and for the more populous clusters they made other measurements such as distance, age, and the amount of reddening of their starlight caused by interstellar dust between them and us.

"We found that most of the clusters are very small and only have about 10-20 stars. Compared to typical open clusters, these are very faint and compact objects -- the dust in front of these clusters makes them appear 10 000 to 100 million times fainter in visible light. It's no wonder they were hidden," explains Radostin Kurtev, another member of the team.

Since antiquity only 2500 open clusters have been found in the Milky Way, but astronomers estimate there might be as many as 30 000 still hiding behind the dust and gas. While bright and large open clusters are easily spotted, this is the first time that so many faint and small clusters have been found at once.

Furthermore, these new 96 open clusters could be only the tip of the iceberg. "We've just started to use more sophisticated automatic software to search for less concentrated and older clusters. I am confident that many more are coming soon," adds Borissova.

*Since 2010, the VISTA Variables in the Via Lactea programme (VVV) has been scanning the central parts of the Milky Way and the southern plane of the galactic disc in infrared light. This program was granted a total of 1929 hours of observing time over a five year period. Via Lactea is the Latin name for the Milky Way.

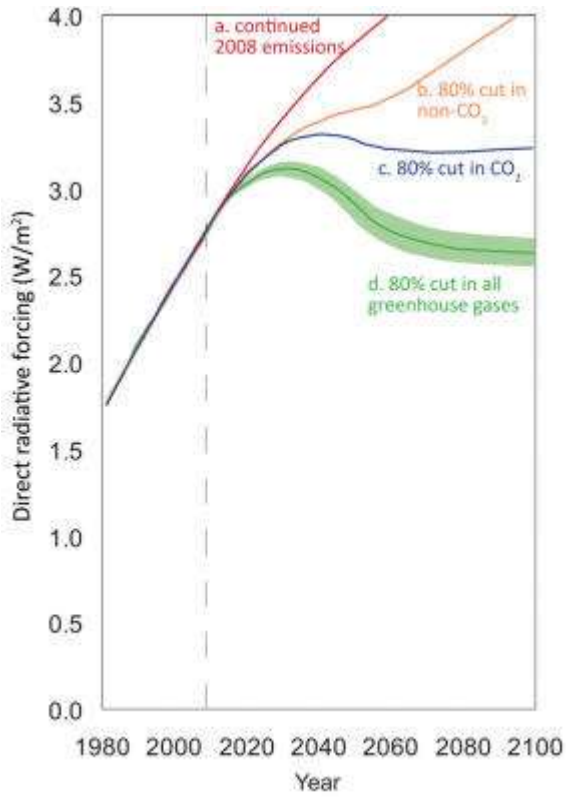
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by European Southern Observatory - ESO.

Journal Reference:

1. Dante Minniti et al. New Galactic Star Clusters in the VVV Survey. *Astronomy & Astrophysics*, 2011 (in press)

http://www.sciencedaily.com/releases/2011/08/110803083642.htm

Slowing Climate Change by Targeting Gases Other Than Carbon Dioxide



The direct radiative forcing (warming effect) of greenhouse gases under various scenarios. a) Red: constant 2008 emissions of both CO2 and non-CO2 greenhouse gases. b) An 80% cut in non-CO2 emissions. c) An 80% cut in CO2 emissions. d) An 80% cut in all greenhouse gas emissions. In all scenarios, emissions cuts are phased in between 2009 and 2050. (Credit: NOAA)

ScienceDaily (Aug. 4, 2011) — Carbon dioxide remains the undisputed king of recent climate change, but other greenhouse gases measurably contribute to the problem. A new study, conducted by NOAA scientists and published online August 3 in *Nature*, shows that cutting emissions of those other gases could slow changes in climate that are expected in the future.

Discussions with colleagues around the time of the 2009 United Nations' climate conference in Copenhagen inspired three NOAA scientists -- Stephen Montzka, Ed Dlugokencky and James Butler of NOAA's Earth System Research Laboratory in Boulder, Colo. -- to review the sources of non-carbon dioxide (CO_2) greenhouse gases and explore the potential climate benefits of cutting their emissions.

Like CO_2, other greenhouse gases trap heat in Earth's atmosphere. Some of these chemicals have shorter lifetimes than CO_2 in the atmosphere. Therefore cutting emissions would quickly reduce their direct radiative forcing -- a measure of warming influence.

"We know that recent climate change is primarily driven by carbon dioxide emitted during fossil-fuel combustion, and we know that this problem is going to be with us a long-time because carbon dioxide is so persistent in the atmosphere," Montzka said. "But lowering emissions of greenhouse gases other than carbon dioxide could lead to some rapid changes for the better."

Scientists know that stabilizing the warming effect of CO_2 in the atmosphere would require a decrease of about 80 percent in human-caused CO_2 emissions -- in part because some of the carbon dioxide emitted today will remain in the atmosphere for thousands of years. In contrast, cutting all long-lived non-CO_2 greenhouse gas emissions by 80 percent could diminish their climate warming effect substantially within a couple of decades. Cutting both CO_2 and non-CO_2 greenhouse gas emissions to this extent could result in a decrease in the total warming effect from these greenhouse gases this century, the new paper shows.

For the new analysis, the researchers considered methane; nitrous oxide; a group of chemicals regulated by an international treaty to protect Earth's ozone layer; and a few other extremely long-lived greenhouse gases currently present at very low concentrations.

The new review paper describes the major human activities responsible for these emissions, and notes that steep cuts (such as 80 percent) would be difficult. Without substantial changes to human behavior, emissions of the non-CO_2 greenhouse gases are expected to continue to increase.

The climate-related benefits of reductions in non-CO_2 greenhouse gases have limits, Montzka and his colleagues showed. Even if all human-related, non-CO_2 greenhouse gas emissions could be eliminated today, it would not be enough to stabilize the warming influence from all greenhouse gases over the next 40 years -- unless CO_2 emissions were also cut significantly.

The scientists also noted in the paper the complicated connections between climate and greenhouse gases, some of which are not yet fully understood. The non-CO_2 gases studied have natural sources as well as human emissions, and climate change could amplify or dampen some of those natural processes, Dlugokencky said. Increasingly warm and dry conditions in the Arctic, for example, could thaw permafrost and increase the frequency of wildfires, both of which would send more methane and carbon dioxide into the atmosphere.

"The long-term necessity of cutting carbon dioxide emissions shouldn't diminish the effectiveness of short-term action. This paper shows there are other opportunities to influence the trajectory of climate change," Butler said. "Managing emissions of non-carbon dioxide gases is clearly an opportunity to make additional contributions."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by National Oceanic and Atmospheric Administration.

Journal Reference:

1. S. A. Montzka, E. J. Dlugokencky, J. H. Butler. Non-CO_2 greenhouse gases and climate change. *Nature*, 2011; 476 (7358): 43 DOI: 10.1038/nature10322

http://www.sciencedaily.com/releases/2011/08/110803133522.htm

Testing the Waters of Abstraction

By KEN JOHNSON

Estate of John Marin/Artists Rights Society, New York

John Marin: Modernism at Midcentury "Grey Sea," an oil from 1938, at the Portland Museum of Art in Maine.

The art of John Marin is easy to respect and hard to love. Compared with his vanguard associates of the between-the-wars era — Georgia O'Keeffe, Arthur Dove, Charles Demuth and Marsden Hartley — he was a flinty pragmatist. In the watercolors for which he was, and remains, most renowned, there is a hectic, sometimes luminously beautiful but often murky struggle between Cubist order and dynamic flux. Applied similarly to Manhattan cityscapes and Maine land- and seascapes, his touch is brusque, and his colors range from garish to drab. The invariably modest scale feels claustrophobic, despite the expansive subjects. Emotion is muted. An astringent pantheism is often suggested, but he was no visionary, and eros, whether carnal or mystical, is almost wholly absent.

But Marin (1870-1953) pushed abstraction in painting harder than any of his compatriots, and for that he was extravagantly admired by people who mattered. Along with O'Keeffe and Dove, he was one of the three American painters most vigorously championed by the photographer and impresario Alfred Stieglitz. In 1942 the soon-to-be-dominant critic of the post-World War II period, Clement Greenberg, opined about Marin that

"it is quite possible that he is the greatest living American painter." In 1948 a Look magazine poll of museum directors and critics had him as American's foremost artist. And in 1950 he was the most prominently featured artist in Alfred Barr's selection of seven painters — including Arshile Gorky, Willem de Kooning and Jackson Pollock — for the American pavilion of the 25th Venice Biennale.

All these "mosts" might puzzle today's viewers, who, I suspect, are more likely to think of Charles Burchfield as the pre-eminent watercolorist of the early-to-mid-20th century. As for painting in oil on canvas, for which Marin was not so celebrated, many others come to mind ahead of him — Edward Hopper for one.

Despite their excellence as an exhibition, the 54 works in "John Marin: Modernism at Midcentury" at the Portland Museum of Art in Maine do little to explain the stature Marin once held in the eyes of his contemporaries. Organized by the independent curator and art historian Debra Bricker Balken for the Portland Museum and the Addison Gallery of American Art at Phillips Academy in Andover, Mass., the show focuses on the last two decades of Marin's life, when his reputation peaked. During that time he summered in Cape Split, Me., an hour's drive east of Bar Harbor, and wintered in Cliffside, N.J. And while continuing to make watercolors, he took up oil painting with renewed sense of purpose.

A mood of frustrated urgency animates the exhibition. In his 60s and 70s, it seems, Marin was as determinedly resistant to complacency as ever. With an always impulsive attack he pursued several different directions without settling on just one and following it all the way. In oil paintings like "Grey Sea" (1938) and "Cape Split" (1940), in which foamy waves break on dark rocks, he recalls the naturalism of Winslow Homer's great, late seascapes, and the generous, brushy application of viscous paint calls to mind the sensuousness of the European expressionist Chaim Soutine. De Kooning took notice, no doubt.

In this exhibition Marin always seems on the verge of some great breakthrough. But he kept reverting to his signature approach, in which he pictured the natural or metropolitan world broken into Cubist patchworks divided by horizontal, vertical and diagonal lines. In a number of instances he added frames with simple, geometric patterns roughly painted on them. Like the lines he characteristically added to the edges and corners of many of his works on canvas and paper, the frames suggest a need to contain and give order to forces of nature and his own impetuousness. They also add a folksy touch, as if to offset his mandarin Modernism with some down-home salt of the earth.

Most surprisingly, in a painting from 1952 called "The Written Sea," he used a syringe to draw with squiggly black lines on a mostly white canvas the view of a rocky coast, with typically toylike boats bobbing on the ocean's horizon. Perhaps he envied the freedom and immediacy of Pollock's drip paintings. Yet he could not give up the conventional, cartoonish structure of the postcard seascape.

In her fine catalog essay Ms. Balken gives a detailed account of Marin's place in the spectrum of midcentury American art. While he was obviously inspired by Europeans like Cézanne, Picasso and Braque, he was committed, along with many other Americans, to the dream of a distinctively native style grounded in a poetic sense of place.

On the other hand, he resisted the regionalist chauvinism of popular artists like Thomas Hart Benton and Grant Wood. Against their illustrative realism and patriotic myth making, Marin sought an equivalence between the energy of nature and the formal and material vitality of painting. But while trying to imbue painting with its own independent life, he was unwilling or unable to depart from traditional representation and go fully abstract.

The essay helps explain, in a way that the show by itself cannot, why Marin was so esteemed by the cognoscenti of his time and why he appears less compelling today. He nimbly avoided the pitfalls of yahooism, academicism, social realism and surrealist kitsch and, in so doing, forged a style that was exemplary for its technical and expressive economy, if not for daring imagination. But within a couple of

years of his death in 1953, his achievement as a leading abstractionist would be totally eclipsed by the Abstract Expressionists. Like Moses, he came within sight of the Promised Land but died before reaching it.

"John Marin: Modernism at Midcentury" runs through Oct. 10 at the Portland Museum of Art, Portland, Me.; (207) 775-6148, portlandmuseum.org.

http://www.nytimes.com/2011/08/05/arts/design/testing-the-waters-of-abstraction.html?ref=design

Six Million Years of Savanna: Grasslands, Wooded Grasslands Accompanied Human Evolution

An East African savanna landscape of tree-dotted grassland is shown in this image from Samburu National Reserve in Kenya. The more heavily vegetated area in the middle distance is the corridor of the Ewaso Ngiro River. A new University of Utah study concludes that savanna was the predominant ecosystem during the evolution of human ancestors and their chimp and gorilla relatives in East Africa. (Credit: Thure Cerling, University of Utah.)

ScienceDaily (Aug. 3, 2011) — University of Utah scientists used chemical isotopes in ancient soil to measure prehistoric tree cover -- in effect, shade -- and found that grassy, tree-dotted savannas prevailed at most East African sites where human ancestors and their ape relatives evolved during the past 6 million years.

"We've been able to quantify how much shade was available in the geological past," says geochemist Thure Cerling, senior author of a study of the new method in the journal *Nature*. "And it shows there have been open habitats for all of the last 6 million years in the environments in eastern Africa where some of the most significant early human fossils were found."

"Wherever we find human ancestors, we find evidence for open habitats similar to savannas -- much more open and savanna-like than forested," adds Cerling, a University of Utah distinguished professor of geology and geophysics, and biology.

Fossils of early humans and their ancestors and extinct relatives have been found in both wooded and open environments in East Africa. Even 4.3-million-year-old Ardipithecus -- which lived in the woods, according to its discoverers -- had a small component of tropical grasses in its diet, Cerling says.

"The fact it had some means it was going into the savanna, unless it was eating takeout food," he says.

Scientists have spent a century debating the significance of savanna landscape in human evolution, including the development of upright walking, increased brain size and tool use.

Part of the problem has been a fuzzy definition of "savanna," which has been used to describe "virtually everything between completely open grasslands and anything except a dense forest," Cerling says. He adds the most common definition is a fairly open, grassy environment with a lot of scattered trees -- a grassland or wooded grassland.

Open Landscapes throughout the Evolution of Humans and Their Relatives

In the new study, Cerling says he and colleagues developed "a new way to quantify the openness of tropical landscapes. This is the first method to actually quantify the amount of canopy cover, which is the basis for deciding if something is savanna."

Cerling does not dispute that East African savannas became more expansive within the past 2 million years, or that human ancestors and relatives likely spent time in narrow "gallery forests" along river corridors.

But he says the new method shows grasslands and wooded grasslands -- in other words, savannas -- have prevailed for more than 6 million years in the cradle of humanity, with tree cover less than about 40 percent at most sites. By definition, woodland has more than 40 percent tree cover, and a forest has more than 80 percent tree cover.

"In some periods, it was more bushy, and other times it was less bushy," he says. "Hardly anything could have been called a dense forest, but we can show some periods where certain environments were consistently more wooded than others. We find hominins (early humans, pre-humans and chimp and gorilla relatives) in both places. How early hominins partitioned their time between 'more open' and 'more closed' habitats is still an open question."

Cerling says even sparse woody canopy provided hominins with shade, some foods and refuge from predators.

Fossil evidence of hominins -- humans, their ancestors and early relatives such as chimps and gorillas -- date back to 4.3 million years and possibly 6 million years, Cerling says. The new method was used to look for and find savanna up to 7.4 million years ago.

"Currently, many scientists think that before 2 million years ago, things were forested [in East Africa] and savanna conditions have been present only for the past 2 million years," Cerling says. "This study shows that during the development of bipedalism [about 4 million years ago] open conditions were present," even predominant.

Cerling conducted the study with biologists Samuel Andanje and David Kimutai Korir of the Kenya Wildlife Service; geologist Michael Bird of James Cook University, Cairns, Australia; University of Utah graduate students William Mace of geology, Anthony Macharia of geography and Christopher Remien of mathematics; and former Utah geology graduate students Jonathan Wynn of the University of South Florida, Naomi Levin of Johns Hopkins University and Jay Quade of the University of Arizona.

The National Science Foundation and the Leakey Foundation funded the study.

Deducing Prehistoric Tree Cover from Soil Isotopes

The new method was developed by correlating carbon isotope ratios in 3,000 modern soil samples with satellite photos of tree and vegetation cover at 75 tropical sites worldwide -- half in Africa -- representing everything from closed forest to open grassland. That allowed scientists to determine the percent of tree and woody shrub cover millions of years ago based on carbon isotope ratios in fossil soils known as paleosols.

"This study is based on the geological axiom that the present is the key to the past," says Cerling. "We assume soils in the past had similar relationships to vegetation as what we observe today."

The researchers collected soil samples at Kenyan and Ethiopian sites and used published data on soil samples collected by others during the past decade at the other sites throughout the tropics. Modern soil samples came from national parks and reserves and non-agricultural areas so that carbon isotope rations reflected natural vegetation.

The ratio of rare carbon-13 to common carbon-12 in decayed plant material in soils reveals the extent to which the landscape was covered by plants that use what is known as the C3 pathway of photosynthesis versus plants that use C4 photosynthesis.

Trees, shrubs, herbs, forbs and cool-season grasses are C3 plants, which include beans and most vegetables. C4 plants are warm-season or tropical grasses that dominate savannas, and plants called sedges. C4 plants have a higher ratio of carbon-13 than C3 plants.

The isotope composition of fossil soil gives a measure of the total makeup of the ecosystem in terms of how much canopy versus how much open landscape, Cerling says. So in a forest, even soil from open gaps shows the C3 signature because of non-woody C3 plants growing there, while on a savanna, soil from under a C3 tree will show the C4 signature because of grasses growing under the tree.

The Findings: A History of Savanna

Cerling and colleagues used the new method to analyze fossil soils and infer plant cover back to 7.4 million years ago, a period that includes when human ancestors and apes split from a common ancestor.

Their analysis of 1,300 fossil soil samples from sites at or near where human ancestors and their relatives evolved shows that more than 70 percent of the sites had less than 40 percent woody cover, meaning they were wooded grasslands or grasslands. Less than 1 percent of the samples reflected sites where tree cover exceeded 70 percent.

"Therefore, 'closed' forests (more than 80 percent woody cover) represent a very small fraction of the environments represented by these paleosols," the researchers write.

"We conclude there have been open savannas all the time for which we have hominin fossils in the environments where the fossils were found during the past 4.3 million years" -- the oldest fossils now accepted as human ancestors, Cerling says.

The researchers also created vegetation chronologies of the Awash Valley of Ethiopia and the Omo-Turkana Basin of Ethiopia and Kenya -- home to many fossils of human ancestors, including Ardipithecus, Australopithecus, Paranthropus and our own genus, Homo.

They found that during the past 7.4 million years, woody cover ranged from 75 percent (closed woodlands) down to 5 percent or less (open grasslands), but significant areas with woody cover below 40 percent (savanna woodlands to savanna grasslands) were consistently present.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Utah.

Journal Reference:

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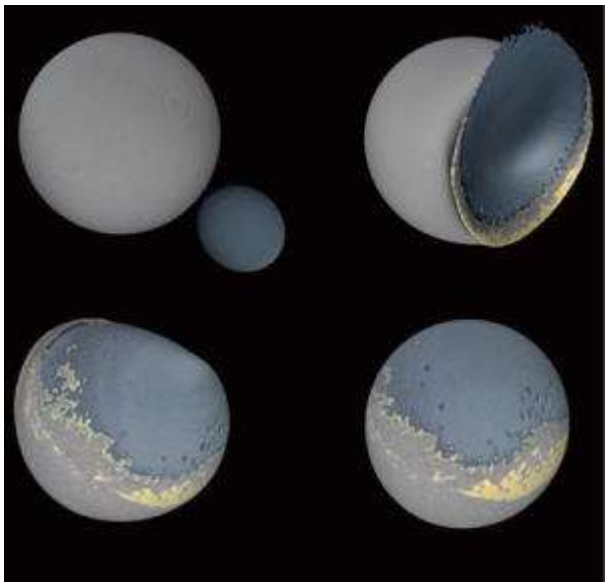
http://www.sciencedaily.com/releases/2011/08/110803133505.htm

'Big Splat' May Explain the Moon's Mountainous Far Side



Four snapshots from the computer simulation of a collision between the moon and a smaller companion moon show most of the companion moon is accreted as a pancake-shaped layer, forming a mountainous region on one side of the moon. (Credit: M. Jutzi and E. Asphaug, Nature.)

ScienceDaily (Aug. 3, 2011) — The mountainous region on the far side of the moon, known as the lunar farside highlands, may be the solid remains of a collision with a smaller companion moon, according to a new study by planetary scientists at the University of California, Santa Cruz.

The striking differences between the near and far sides of the moon have been a longstanding puzzle. The near side is relatively low and flat, while the topography of the far side is high and mountainous, with a much thicker crust. The new study, published in the August 4 issue of *Nature*, builds on the "giant impact" model for the origin of the moon, in which a Mars-sized object collided with Earth early in the history of the solar system and ejected debris that coalesced to form the moon. The study suggests that this giant impact also created another, smaller body, initially sharing an orbit with the moon, that eventually fell back onto the moon and coated one side with an extra layer of solid crust tens of kilometers thick.

"Our model works well with models of the moon-forming giant impact, which predict there should be massive debris left in orbit about the Earth, besides the moon itself. It agrees with what is known about the dynamical stability of such a system, the timing of the cooling of the moon, and the ages of lunar rocks," said Erik Asphaug, professor of Earth and planetary sciences at UC Santa Cruz.

Asphaug, who coauthored the paper with UCSC postdoctoral researcher Martin Jutzi, has previously done computer simulations of the moon-forming giant impact. He said companion moons are a common outcome of such simulations.

In the new study, he and Jutzi used computer simulations of an impact between the moon and a smaller companion (about one-thirtieth the mass of the moon) to study the dynamics of the collision and track the evolution and distribution of lunar material in its aftermath. In such a low-velocity collision, the impact does not form a crater and does not cause much melting. Instead, most of the colliding material is piled onto the impacted hemisphere as a thick new layer of solid crust, forming a mountainous region comparable in extent to the lunar farside highlands.

"Of course, impact modelers try to explain everything with collisions. In this case, it requires an odd collision: being slow, it does not form a crater, but splats material onto one side," Asphaug said. "It is something new to think about."

He and Jutzi hypothesize that the companion moon was initially trapped at one of the gravitationally stable "Trojan points" sharing the moon's orbit, and became destabilized after the moon's orbit had expanded far from Earth. "The collision could have happened anywhere on the moon," Jutzi said. "The final body is lopsided and would reorient so that one side faces Earth."

The model may also explain variations in the composition of the moon's crust, which is dominated on the near side by terrain comparatively rich in potassium, rare-earth elements, and phosphorus (KREEP). These elements, as well as thorium and uranium, are believed to have been concentrated in the magma ocean that remained as molten rock solidified under the moon's thickening crust. In the simulations, the collision squishes this KREEP-rich layer onto the opposite hemisphere, setting the stage for the geology now seen on the near side of the moon.

Other models have been proposed to explain the formation of the highlands, including one published last year in Science by Jutzi and Asphaug's colleagues at UC Santa Cruz, Ian Garrick-Bethell and Francis Nimmo. Their analysis suggested that tidal forces, rather than an impact, were responsible for shaping the thickness of the moon's crust.

"The fact that the near side of the moon looks so different to the far side has been a puzzle since the dawn of the space age, perhaps second only to the origin of the moon itself," said Nimmo, a professor of Earth and planetary sciences. "One of the elegant aspects of Erik's article is that it links these two puzzles together: perhaps the giant collision that formed the moon also spalled off some smaller bodies, one of which later fell back to the Moon to cause the dichotomy that we see today."

For now, he said, there is not enough data to say which of the alternative models offers the best explanation for the lunar dichotomy. "As further spacecraft data (and, hopefully, lunar samples) are obtained, which of these two hypotheses is more nearly correct will become clear," Nimmo said.

The new study was supported by NASA's Planetary Geology and Geophysics Program. Simulations were run on the NSF-sponsored UC Santa Cruz astrophysics supercomputer pleiades.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of California - Santa Cruz.

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http://www.sciencedaily.com/releases/2011/08/110803133519.htm

Lifestyles of the Old and Healthy Defy Expectations

People who live to 95 or older are no more virtuous than the rest of us in terms of their diet, exercise routine or smoking and drinking habits, according to new research. The U.S. Census Bureau estimates there were nearly 425,000 people aged 95 and older living in the U.S. in 2010 ? a fraction (.01) of the 40 million U.S. adults 65 and over. (Credit: © Sara Robinson / Fotolia)

ScienceDaily (Aug. 3, 2011) — People who live to 95 or older are no more virtuous than the rest of us in terms of their diet, exercise routine or smoking and drinking habits, according to researchers at Albert Einstein College of Medicine of Yeshiva University.

Their findings, published August 3 in the online edition of *Journal of the American Geriatrics Society*, suggests that "nature" (in the form of protective longevity genes) may be more important than "nurture" (lifestyle behaviors) when it comes to living an exceptionally long life. Nir Barzilai, M.D., the Ingeborg and Ira Leon Rennert Chair of Aging Research and director of the Institute for Aging Research at Einstein, was the senior author of the study.

Dr. Barzilai and his Einstein colleagues interviewed 477 Ashkenazi Jews who were living independently and were 95 and older (95-112, 75 percent of them women). They were enrolled in Einstein's Longevity Genes Project, an ongoing study that seeks to understand why centenarians live as long as they do. (Descended from a small founder group, Ashkenazi Jews are more genetically uniform than other populations, making it easier to spot gene differences that are present.)

The elderly participants were asked about their lifestyles at age 70, considered representative of the lifestyle they'd followed for most of their adult lives. They answered questions about their weight and height so that their body mass index (BMI) could be calculated. They also provided information about their alcohol consumption, smoking habits, physical activity, and whether they ate a low-calorie, low-fat or low-salt diet.

To compare these long-lived individuals with the general population, the researchers used data from 3,164 people who had been born around the same time as the centenarians and were examined between 1971 and 1975 while participating in the National Health and Nutrition Examination Survey (NHANES I).

Overall, people with exceptional longevity did not have healthier habits than the comparison group in terms of BMI, smoking, physical activity, or diet. For example, 27 percent of the elderly women and an equal percentage of women in the general population attempted to eat a low-calorie diet. Among long-living men, 24 percent consumed alcohol daily, compared with 22 percent of the general population. And only 43 percent of male centenarians reported engaging in regular exercise of moderate intensity, compared with 57 percent of men in the comparison group.

"In previous studies of our centenarians, we've identified gene variants that exert particular physiology effects, such as causing significantly elevated levels of HDL or 'good' cholesterol," said Dr. Barzilai, who is also professor of medicine and of genetics at Einstein. "This study suggests that centenarians may possess additional longevity genes that help to buffer them against the harmful effects of an unhealthy lifestyle."

The research did find, however, that overweight centenarians tended to have lower rates of obesity than the control group. Although male and female centenarians were just as likely to be overweight as their counterparts in the general population, the centenarians were significantly less likely to become obese: only 4.5 percent of male centenarians were obese vs. 12.1 percent of controls; and for women, 9.6 percent of centenarians were obese versus 16.2 percent of controls. Both of these differences are statistically significant.

While longevity genes may protect centenarians from bad habits, healthy lifestyle choices remain critical for the vast majority of the population. The U.S. Census Bureau estimates there were nearly 425,000 people aged 95 and older living in the U.S. in 2010 − a fraction (.01) of the 40 million U.S. adults 65 and over.

"Although this study demonstrates that centenarians can be obese, smoke and avoid exercise, those lifestyle habits are not good choices for most of us who do not have a family history of longevity," said Dr. Barzilai. "We should watch our weight, avoid smoking and be sure to exercise, since these activities have been shown to have great health benefits for the general population, including a longer lifespan."

Researchers also asked study participants why they believed they had lived so long. Most did not attribute their advanced age to lifestyle factors. One-third reported a history of family longevity, while 20 percent believed that physical activity also played a role in their lifespan. Other factors included positive attitude (19 percent), busy or active life (12 percent), less smoking and drinking (15 percent), good luck (8 percent), and religion or spirituality (6 percent).

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Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Albert Einstein College of Medicine.

Journal Reference:

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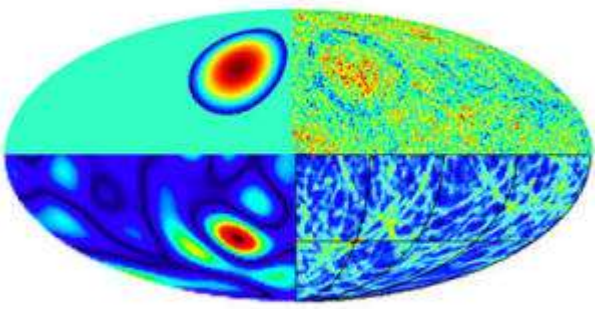
http://www.sciencedaily.com/releases/2011/08/110803083639.htm

Is Our Universe Inside a Bubble? First Observational Test of the 'Multiverse'



The signatures of a bubble collision at various stages in the analysis pipeline. A collision (top left) induces a temperature modulation in the CMB temperature map (top right). The 'blob' associated with the collision is identified by a large needlet response (bottom left), and the presence of an edge is highlighted by a large response from the edge detection algorithm (bottom right). In parallel with the edge-detection step, we perform a Bayesian parameter estimation and model selection analysis. (Credit: Image courtesy of University College London)

ScienceDaily (Aug. 3, 2011) — The theory that our universe is contained inside a bubble, and that multiple alternative universes exist inside their own bubbles -- making up the 'multiverse' -- is, for the first time, being tested by physicists.

Two research papers published in *Physical Review Letters* and *Physical Review D* are the first to detail how to search for signatures of other universes. Physicists are now searching for disk-like patterns in the cosmic microwave background (CMB) radiation -- relic heat radiation left over from the Big Bang -- which could provide tell-tale evidence of collisions between other universes and our own.

Many modern theories of fundamental physics predict that our universe is contained inside a bubble. In addition to our bubble, this `multiverse' will contain others, each of which can be thought of as containing a universe. In the other 'pocket universes' the fundamental constants, and even the basic laws of nature, might be different.

Until now, nobody had been able to find a way to efficiently search for signs of bubble universe collisions -- and therefore proof of the multiverse -- in the CMB radiation, as the disc-like patterns in the radiation could be located anywhere in the sky. Additionally, physicists needed to be able to test whether any patterns they detected were the result of collisions or just random patterns in the noisy data.

A team of cosmologists based at University College London (UCL), Imperial College London and the Perimeter Institute for Theoretical Physics has now tackled this problem.

"It's a very hard statistical and computational problem to search for all possible radii of the collision imprints at any possible place in the sky," says Dr Hiranya Peiris, co-author of the research from the UCL Department of Physics and Astronomy. "But that's what pricked my curiosity."

The team ran simulations of what the sky would look like with and without cosmic collisions and developed a ground-breaking algorithm to determine which fit better with the wealth of CMB data from NASA's Wilkinson Microwave Anisotropy Probe (WMAP). They put the first observational upper limit on how many bubble collision signatures there could be in the CMB sky.

Stephen Feeney, a PhD student at UCL who created the powerful computer algorithm to search for the tell-tale signatures of collisions between "bubble universes," and co-author of the research papers, said: "The work represents an opportunity to test a theory that is truly mind-blowing: that we exist within a vast multiverse, where other universes are constantly popping into existence."

One of many dilemmas facing physicists is that humans are very good at cherry-picking patterns in the data that may just be coincidence. However, the team's algorithm is much harder to fool, imposing very strict rules on whether the data fits a pattern or whether the pattern is down to chance.

Dr Daniel Mortlock, a co-author from the Department of Physics at Imperial College London, said: "It's all too easy to over-interpret interesting patterns in random data (like the 'face on Mars' that, when viewed more closely, turned out to just a normal mountain), so we took great care to assess how likely it was that the possible bubble collision signatures we found could have arisen by chance."

The authors stress that these first results are not conclusive enough either to rule out the multiverse or to definitively detect the imprint of a bubble collision. However, WMAP is not the last word: new data currently coming in from the European Space Agency's Planck satellite should help solve the puzzle.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University College London.

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1. Stephen M. Feeney, Matthew C. Johnson, Daniel J. Mortlock, Hiranya V. Peiris. First Observational Tests of Eternal Inflation: Analysis Methods and WMAP 7-Year Results. *Physical Review D*, 2011; (in press)
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Breeding Crops With Deeper Roots Could 'Slash CO_2 Levels'

New research suggests that breeding crops with roots a meter deeper in the ground could lower atmospheric carbon dioxide levels dramatically, with significant environmental benefits. (Credit: iStockphoto/Orlando Rosu)

ScienceDaily (Aug. 3, 2011) — Breeding crops with roots a metre deeper in the ground could lower atmospheric CO_2 levels dramatically, with significant environmental benefits, according to research by a leading University of Manchester scientist.

Writing in the *Annals of Botany*, Professor Douglas Kell argues that developing crops that produce roots more deeply in the ground could harvest more carbon from the air, and make crops more drought resistant, while dramatically reducing carbon levels.

In principle, any crops could be treated in this way, giving more productive yields while also being better for the environment.

Although the amount of carbon presently sequestered in the soil in the natural environment and using existing crops and grasses has been known for some time, Professor Kell's new analysis is the first to reveal the benefits to the environment that might come from breeding novel crops with root traits designed to enhance carbon sequestration.

Professor Kell, Professor of Bioanalytical Science at the University as well as Chief Executive of the Biotechnology and Biological Sciences Research Council (BBSRC), has also devised a carbon calculator that can show the potential benefits of crops that burrow more deeply in the ground.

With this, he has calculated that -- depending on the time it takes them to break down -breeding crops that could cover present cropland areas but that had roots a metre deeper in the soil could double the amount of carbon captured from the environment. This could be a significant weapon in the fight against climate change.

The soil represents a reservoir that contains at least twice as much carbon as does the atmosphere, yet mainly just the above-ground plant biomass is harvested in agriculture, and plant photosynthesis represents the effective origin of the overwhelming bulk of soil carbon.

Breeding crop plants with deeper and bushy root ecosystems could simultaneously improve both the soil structure and its steady-state carbon, water and nutrient retention, as well as sustainable plant yields.

Professor Kell argues that widespread changes in agricultural practice are needed, in an environment in which edible crop yields also need to increase substantially and sustainably, and where transport fuels and organic chemicals will need to come from modern (rather than fossil) photosynthesis.

It is known that massive CO_2 reductions in the atmosphere over geological time have happened because of the rise of deep-rooted trees and flowering plants.

Most cultivated agricultural crops have root depths that do not extend much beyond one metre. Doubling this, Professor Kell argues, would dramatically reduce CO_2 levels.

Existing studies, which have doubted the benefits of deep roots in carbon sequestration, do not make soil measurements much below a metre, and the kinds of root depths proposed by Professor Kell would more than double that.

He said: "This doubling of root biomass from a nominal 1m to a nominal 2m is really the key issue, together with the longevity of the roots and carbon they secrete and sequester below-ground.

"What matters is not so much what is happening now as what might be achieved with suitable breeding of plants with deep and reasonably long-lived roots. Many such plants exist, but have not been bred for agriculture.

"In addition to the simple carbon sequestration that this breeding could imply -- possibly double that of common annual grain crops -- such plants seem to mobilise and retain nutrients and water very effectively over extended periods, thus providing resistance to drought, flooding and other challenges we shall face from climate change.

"While there is a way to go before such crops might have, for example, the grain yields of present day cereals, their breeding and deployment seems a very promising avenue for sustainable agriculture."

The carbon sequestration calculator is at http://dbkgroup.org/carbonsequestration/rootsystem.html

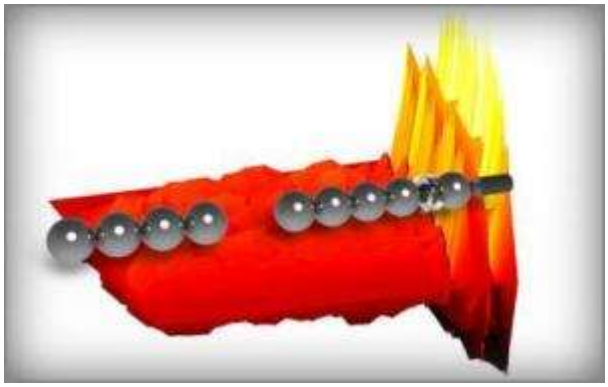
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Manchester.

Journal Reference:

1. Douglas B. Kell. Breeding crop plants with deep roots: their role in sustainable carbon, nutrient and water sequestration. *Annals of Botany*, 2011; DOI: 10.1093/aob/mcr175

http://www.sciencedaily.com/releases/2011/08/110803083502.htm

Engineers Develop One-Way Transmission System for Sound Waves



The nonlinearity and asymmetry present in this chain of compressed spheres can transform vibrations of one frequency, applied at one end of the chain, to vibrations with broadband frequency content leading to rectification. The amplitude of the vibrations are shown by the height of the peaks. (Credit: Chiara Daraio / Caltech)

ScienceDaily (Aug. 3, 2011) — While many hotel rooms, recording studios, and even some homes are built with materials to help absorb or reflect sound, mechanisms to truly control the direction of sound waves are still in their infancy. However, researchers at the California Institute of Technology (Caltech) have now created the first tunable acoustic diode-a device that allows acoustic information to travel only in one direction, at controllable frequencies.

The mechanism they developed is outlined in a paper published on July 24 in the journal *Nature Materials*.

Borrowing a concept from electronics, the acoustic diode is a component that allows a current -- in this case a sound wave -- to pass in one direction, while blocking the current in the opposite direction. "We exploited a physical mechanism that causes a sharp transition between transmitting and nontransmitting states of the diode," says Chiara Daraio, professor of aeronautics and applied physics at Caltech and lead author on the study. "Using experiments, simulations, and analytical predictions, we demonstrated the one-way transmission of sound in an audible frequency range for the first time."

This new mechanism brings the idea of true soundproofing closer to reality. Imagine two rooms labeled room A and room B. This new technology, Daraio explains, would enable someone in room A to hear sound coming from room B; however, it would block the same sound in room A from being heard in room B.

"The concept of the one-way transmission of sound could be quite important in architectural acoustics, or the science and engineering of sound control within buildings," says Georgios Theocharis, a postdoctoral scholar in Daraio's laboratory and a co-author of the study.

The system is based on a simple assembly of elastic spheres -- granular crystals that transmit the sound vibrations -- that could be easily used in multiple settings, can be tuned easily, and can potentially be scaled to operate within a wide range of frequencies, meaning its application could reach far beyond soundproofing.

Similar systems have been demonstrated by other scientists, but they all feature smooth transitions between transmitting and nontransmitting states instead of the sharp transitions needed to be more effective at controlling the flow of sound waves. To obtain the sharp transition, the team created a periodic system with a small defect that supports this kind of quick change from an "on" to an "off" transmission state. According to

Daraio, this means the system is very sensitive to small variations of operational conditions, like pressure and movement, making it useful in the development of ultrasensitive acoustic sensors to detect sound waves. The system can also operate at different frequencies of sound and is capable of downshifting, or reducing the frequency of the traveling signals, as needed.

"We propose to use these effects to improve energy-harvesting technologies," she says. "For example, we may be able to scavenge sound energy from undesired structural vibrations in machinery by controlling the flow of sound waves away from the machinery and into a transducer. The transducer would then convert the sound waves into electricity." Daraio says the technology can also shift the undesired frequencies to a range that enables a more efficient conversion to electricity.

The team plans to continue studying the fundamental properties of these systems, focusing on their potential application to energy-harvesting systems. They also believe that these systems may be applicable to a range of technologies including biomedical ultrasound devices, advanced noise control, and even thermal materials aimed at temperature control.

"Because the concepts governing wave propagation are universal to many systems, we envision that the use of this novel way to control energy might enable the design of many advanced thermal and acoustic materials and devices," says Daraio.

The research was supported by the National Science Foundation, the Office of Naval Research, and the A. S. Onassis Benefit Foundation.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by California Institute of Technology. The original article was written by Katie Neith.

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Darth Vader vs. Death Strip

Berlin Wall Sinks into Cold War Disneyland

By Frank Hornig

Politicians in Berlin are searching for a suitable way to commemorate the construction of the Berlin Wall. But the most prominent scenes around the former partition are increasingly being exploited by creative entrepreneurs.

André Prager has sold many things in his life. First he tried his hand at fruit and vegetables, later switching to hawk sweets as a salesman for an Italian chocolate company. Then he discovered the Berlin Wall and its business potential.

Sitting in his sales office, Prager, 39, is beaming from ear to ear. His company's "Trabi Safaris" are a huge hit, with tourists from around the world touring the route of the former Berlin Wall in Trabants, East German-made cars with rattling two-stroke engines. "Discover the last relics of real-life socialism," he promises his customers.

With their unwieldy gearshifts and smelly exhaust fumes, the 120 Trabants in Prager's fleet provoke loud outbursts of laughter from his international guests already at the beginning of the tour. Guides try their best to recreate the odd world behind the Wall. "Safari" guests are subjected to traffic checks by men dressed as officers of the former East German police force. A now they are also forced to exchange their euros for East German marks, which they can spend on such classic Socialist fare such as "Solyanka," a Russian soup, or an Eastern European version of ragoût fin.

But are businesses like this trivializing East German history?

Gazing out from under a baseball cap emblazoned with the image of a skull, the businessman looks surprised when he hears the question. "The Trabi isn't a symbol of oppression," Prager, who was an East German citizen before he became an entrepreneur, says. Instead, it represents "deceleration" and the yearning for a simpler world, he adds. "Anyone who can make money with it should give it a go."

Kitsch and Memorials, Side-by-Side

This week marks the 50th anniversary of the construction of the Berlin Wall, a date the city is commemorating in extremes. Creative entrepreneurs and senior government officials are addressing the Wall and its consequences in very different ways, with kitsch and serious remembrances often featured side-by-side.

On Aug. 13, the president, the chancellor and other top politicians will attend a ceremony at the Berlin Wall memorial on Bernauer Strasse. There will be serious speeches, and once again there will be much talk of how, where and from which perspective the state and German society should commemorate the 136 Berlin residents who died at the Wall, along with German partition in general and the injustices of the East German dictatorship.

Meanwhile business is booming for entrepreneurs seeking to capitalize on the anniversary. East Germany is being reborn as a tourist attraction. In a number of central locations, its former capital has the feel of a big amusement park, like some tongue-in-cheek Haunted Mansion in which the ghosts of the past entertain the tourist audience -- with the friendly support of people who dress up as Mickey Mouse, Indian chiefs and Darth Vader from the "Star Wars" saga and routinely pose for photographs in front of the Brandenburg Gate.

Business is so brisk that politicians and conservators are seriously discussing whether Berlin is turning into a Cold War Disneyland. Some are even calling it a "Venice effect." They worry that a Berlin that succumbs to hordes of tourists could ossify into scenery of the country's East German and Nazi past -- a museum of the 20th century.

The developments are creating a competition in the German capital between business and commemoration of sensitive events, tourist entertainment and a public culture of remembrance. At issue is who gets to tell the story of Germany's division -- and which original locations in the city are used to convey it.

Fragments of History

For years, most Berliners wanted nothing more than to see the Wall disappear. They objected to what they saw as a badge of shame, and they wanted the city to grow together. They were more interested in starting the reconstruction of an imperial palace that was destroyed long ago than in preserving anything more than just a few fragments of a still extant monument to world history.

The Germans, in keeping with their reputation for thoroughness, removed 99 percent of the border facilities. In doing so, they also dismantled a concrete memory of the horrors of German division and discarded what could have been a memorial for future generations.

What remained were remnants for historic preservationists, including half-destroyed concrete sections of the wall that recently underwent a so-called "stress test" to assess their risk of collapse.

Thus the Wall, which the East Germans had officially dubbed an anti-fascist protective barrier, finally became a wall in people's minds, an imaginary place that various players from the federal and state governments now seek to occupy. Some prefer to emphasize the victory of freedom and the market economy, while others would rather draw attention to the policy of détente and the East German civil rights movement.

These differing visions have led to years of intensive debate over suitable forms of commemoration. Meanwhile, entrepreneurs and private citizens have already co-opted the most prominent sites of German partition, imposing their own concept and business ideas.

'Costumed Border Guards Are a Slap in the Face to Victims'

Checkpoint Charlie is a case in point. In 1961, Soviet and American tanks faced off at the Allied border crossing on Friedrichstrasse. Today, entertainers dressed as Allied soldiers smile and pose for photos at the site.

A private Berlin Wall museum has also established itself as a tourist magnet for the city, second only in popularity to the famed Pergamon Museum of archeological artifacts including Babylon's Ishtar Gate. Some 865,000 visitors a year visit the museum to marvel at its dusty permanent exhibit of old spring guns and displays depicting the most ludicrous of escape attempts.

But the Berlin city-state government, the Senate, which is controlled by a coalition of the center-left Social Democratic Party (SPD) and the Left Party, also wants to make its presence felt at Checkpoint Charlie. A public museum has been planned at the site since 2006. "We have an educational mission," says André Schmitz, Berlin's secretary of culture. "Berlin has been sleeping for too long, allowing the Berlin Wall museum to monopolize the narrative at this site."

City officials envision a Cold War Center, which would bring together the memorial and museums in Berlin that focus on various aspects of German division and provide an overarching view of history, or what historians refer to as a "master narrative."

Rainer Klemke, the man in charge of monuments and memorials in Schmitz's culture administration, has campaigned for the establishment of a Cold War Center for years. "We have a plan, we have a feasibility study and we have an investor who is providing us with space in a new building directly at Checkpoint Charlie." Klemke wants the permanent exhibit to have "multiple perspectives," thereby avoiding triumphant Western gestures.

SPD politician Markus Meckel, East Germany's last foreign minister, also supports a new museum at Checkpoint Charlie, because he feels that the Wall's international role in the history of the 20th century in Berlin is not being appropriately displayed.

Had Ronald Reagan outspent the Eastern Block in the arms race to the point that, broke from trying to keep up, Soviet President Mikhail Gorbachev had no choice but to comply with the words the US president said before the Brandenburg Gate, "Mr. Gorbachev, tear down this wall!"? Or had West German politician Egon Bahr's policy of détente already paved the way to reunification? Or did East German civil rights activists bring about the end?

Finally, what role did the Wall play for other Europeans, and for Russians, Chinese, Americans and their children, who are now flocking to Berlin to spend their vacations there?

An Ongoing Dispute over Berlin's Monuments

"Sometimes we have an overly provincial perspective in Berlin," says Meckel, explaining that the various perspectives will be seriously addressed in the Berlin Wall center. "The international visitors should be able to identify with the place. It cannot provide a purely black-and-white portrayal."

World leaders, like former Czech President Vaclav Havel, former US Secretary of State James Baker and former French Foreign Minister Roland Dumas, have signed a petition calling for the establishment of the new museum. The only problem is that Meckel is making no headway with the German government. "Why this official disinterest?" he asks. Minister of State for Culture Bernd Neumann, a member of the center-right

Christian Democratic Union (CDU), has listened to his cause, says Meckel, but there has been no reaction to date. Neumann is currently on vacation and his office has declined to comment.

But this much has become clear in recent months: The ongoing dispute over Berlin's many monuments hasn't exactly aroused the enthusiastic interest of Chancellor Angela Merkel's top culture official.

There are many traps to be avoided. "I find it extremely disconcerting to see the plans for the center being promoted," says Hubertus Knabe, the controversial director of the memorial at the former Hohenschönhausen prison, run by the feared East German police, the Stasi. "After all, the Wall wasn't built by the Cold War but by the East German Communist Party."

Knabe wants the victims of the East German dictatorship to be afforded more respect, even on the street. "Costumed border guards in downtown Berlin are a slap in the face for the victims," he says. "Germany should apply the same laws as other former Soviet bloc countries and impose strict legal limits on the use of Socialist symbols."

If that happened, students and panhandlers could no longer earn money dressing up as Stasi officers, soldiers in the East German army or East German police officers, just as German law forbids the wearing of Nazi uniforms and symbols. Costumed border guards who stamp tourist passports at Berlin's Potsdamer Platz square with the words "Original East German visa" would have to move on.

Berlin Has Become Europe's Third-Most Popular Tourist Destination

There has probably never been as much interest in contemporary history in Berlin as there seems to be at the moment, and many visitors are willing to wait in line for such attractions. In 1996, the city's monuments and contemporary history museums saw only 600,000 visitors. That number has since shot up to 5.5 million a year.

Based on the number of overnight stays, Berlin even surpassed Rome last year and is now Europe's third-most popular tourist destination. "Berliners haven't quite caught on to the fact that they are now playing in the same league with London and Paris," says Burkhard Kieker, the city's tourism director. The visitors are especially interested in the partition of Germany. Many would prefer to see the Wall in its undamaged original state, complete with all the structural details of the horrors associated with it. Kieker is well aware of how politically explosive a rebuilt section of the Wall would be. Nevertheless, he says, "that sort of thing would be a tremendous attraction."

Stasi prison director Knabe even feels that this is long overdue. "The border facilities, in their full monstrosity, should at least be rebuilt in one spot."

Should Wall Remnants Be UNESCO World Heritage?

Technically, it wouldn't be much of a problem to rebuild the Wall. Some of its old elements are still in use today, as walls in a city recycling facility, while others can be found in a Berlin cement factory and in former East German agricultural cooperatives. Perhaps it's only a matter of time before entrepreneurs take a stab at reconstruction.

This would probably not be much of a surprise to conservative CDU member Monika Grütters, who chairs the culture affairs committee in the German parliament, the Bundestag. She also heads the Brandenburg Gate Foundation, which is supported by the state-owned bank Landesbank Berlin and has its offices in a building on the right side of the gate, where the artist Max Liebermann once lived.

Grütters is horrified whenever she steps outside and sees loud young people and bellowing men riding by on so-called beer bikes. On some days there are pickle-eating contests, and on others there are events like the Mercedes Benz Fashion Week. The city issues permits for about 80 events a year on Pariser Platz, the square in front of the Brandenburg Gate.

"Pariser Platz is deteriorating into the nation's fairground," says Grütters, noting that everyone is now allowed to hang a logo on the Brandenburg Gate. "The Berlin Senate has turned it into carnival grounds."

UNESCO Conditions Met, Study Says

There is one place, however, where commemoration and commerce are still kept largely separate. Only two kilometers from the Brandenburg Gate, Axel Klausmeier manages the Berlin Wall Memorial on Bernauer Strasse. It is the best-preserved section of the old border facilities. The Wall itself, a signal fence, a secondary wall and a watchtower are still preserved in relatively good condition.

The program there is the antithesis of Disneyfication. It shows the wall with all of the wounds of time, including those inflicted by so-called *Mauerspechte* (wall peckers). "It is precisely in this compromised condition that it becomes a historic monument," says Klausmeier, the director of the memorial.

Sometimes, when a Trabi Safari stops at Bernauer Strasse, Klausmeier explains to the baffled participants that they are driving on the wrong side of the Wall. "You are in the French sector here," he informs them. When youths wearing East German uniforms recently entered the former death strip, he threw them out. "This is a memorial for the victims," he told them.

Klausmeier has walked the former inner and outer boundaries of West Berlin several times. In the process, he has catalogued 1,800 relics of the old border, many of them now almost unrecognizable as such.

And now he wants the remains of the Wall to be declared a UNESCO World Heritage Site. All the conditions have been met, a study has just confirmed. But Berlin's leaders are reluctant to submit an application. "It's probably too much of a political issue," says Klausmeier.

Translated from the German by Christopher Sultan

URL:

- http://www.spiegel.de/international/spiegel/0,1518,778941,00.html

Some Plants Duplicate Their DNA to Overcome Adversity

Some cultivars of Arabidopsis thaliana repeatedly duplicate their chromosomes in response to grazing. (Credit: L. Brian Stauffer)

ScienceDaily (Aug. 3, 2011) — Whatever does not kill a plant may actually make it stronger. After being partially eaten by grazing animals, for example, some plants grow bigger and faster and reproduce more successfully than they otherwise would. In a new study, researchers report that one secret to these plants' post-traumatic triumph lies in their ability to duplicate their chromosomes -- again and again -- without undergoing cell division.

While this process, called "endoreduplication," is not new to science, no previous study had looked at it in relation to the seemingly miraculous burst of growth and reproductive fitness that occurs in many plants after they have been grazed, said University of Illinois animal biology professor Ken Paige, who conducted the study with doctoral student Daniel Scholes.

"If you talk to a molecular biologist, they might know what endoreduplication is, but they haven't looked at it from the perspective of whole plant reproductive success," Scholes said. "We tried to link the two and found out there is a link there."

The study appears in the journal *Ecology*.

The researchers looked at *Arabidopsis thaliana*, a flowering plant in the mustard family that repeatedly duplicates its chromosomes in some cell types. The plant begins with only 10 chromosomes -- five from each parent -- but after repeated duplications, some cells contain up to 320 chromosomes.

The researchers compared the DNA content of two cultivars of A. thaliana that respond very differently to being grazed. Of the 160 specimens of each cultivar studied, half were artificially grazed (by clipping their central stems) and half were not. One of the cultivars, Columbia, rebounded dramatically after clipping, quickly regrowing stems and leaves and producing more seeds than the unclipped plants. In the other cultivar, Landsberg erecta, growth remained steady after clipping and the level of seed production declined.

A look at the number of chromosomes in the tissues of each plant type before and after clipping revealed that Columbia was able to rebound in part by speeding up endoreduplication in some tissues after clipping. Its sister cultivar, Landsberg erecta, however, did not.

"The overall DNA content goes up in one of the cultivars after clipping, but it doesn't change in the other," Paige said. "And we think it's that added boost that increases its reproductive success."

The added DNA content could allow the plants to increase production of proteins that are needed for growth and reproduction, Scholes said. More DNA also means larger cells.

"Because you have more DNA in the nucleus, you must have a greater nuclear volume, which causes your entire cell to get bigger," Scholes said. Increases in the size of individual cells can ultimately lead to an increase in the size of the whole plant.

"We tend to think that what you inherit is what you're stuck with," Scholes said. "But we're finding that plants are increasing what they have, and for the first time we're beginning to understand how they do that, and why."

In earlier studies conducted over 30 years, Paige found that -- even in natural settings -- plants can evolve the ability to bounce back after grazing.

"We've tracked the plants through generations, so we know that the ones that get eaten actually have up to a three-fold reproductive advantage over the ones that are never eaten," he said. "Now we are beginning to understand the molecular mechanisms that make this possible."

The National Science Foundation and the University of Illinois Research Board funded this study.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Illinois at Urbana-Champaign.

Journal Reference:

1. Daniel R. Scholes, Ken N. Paige. Chromosomal plasticity: mitigating the impacts of herbivory. *Ecology*, 2011; 92 (8): 1691 DOI: 10.1890/10-2269.1

http://www.sciencedaily.com/releases/2011/08/110801094715.htm

First True View of Global Erosion

These cliffs at Utah's Capitol Reef National Park will, eventually, wear away. But how fast? New UVM research sheds light on global erosion rates. (Credit: Eric Portenga)

ScienceDaily (Aug. 2, 2011) — Every mountain and hill shall be made low, declared the ancient prophet Isaiah. In other words: erosion happens. But for the modern geologist a vexing question remains: how fast does this erosion happen?

For more than a century, scientists have looked for ways to measure and compare erosion rates across differing landscapes around the globe -- but with limited success.

"Knowing the background rate of erosion for a place is extremely important," says University of Vermont geologist Paul Bierman, "if you want to compare it to what's coming off the landscape today because of human impacts like agriculture, development, and forestry."

Since the mid-1980's, measurements of a rare radioactive element -- beryllium-10 that appears in quartz bombarded by cosmic rays in the top few feet of Earth's surface -- have greatly improved geologists' ability to estimate erosion rates. But these experiments have been done on a local or regional scale, using a variety of methods, calculation constants, and corrections. Comparisons between climate zones and differing rock types have been difficult -- cutting off a global perspective.

Now Bierman and his graduate student, Eric Portenga, have taken twenty years worth of this disparate data, compiled 1599 measurements from eighty-seven sites around the world, and recalculated it with a single, up-to-date method.

Their work, "provides the first broad, standardized view of pre-human, geologic erosion rates," they write in "Understanding Earth's eroding surface with ^{10}Be," published in the August edition of *GSA Today*, an open-access journal, available online July 26, 2011.

Sustainable Soil

"Nobody has stepped back far enough to look at this big picture," says Bierman, "we all work on our little postage stamps of the world -- Africa, South America, the western US." But many of the pressing questions about erosion are global in scale.

Most urgent, the ability to support the nine billion people forecast to be living on Earth by mid-century rests directly on the resiliency of soil systems and the health of water supplies. And these two pillars of sustainability are directly and deeply affected by erosion.

The method used in this new study can provide a good tool for measuring the sustainability of modern agricultural practices, Bierman notes, since the beryllium-10 data shows the rate at which landscapes have been changing in the recent geologic past: the last thousand to several-hundred-thousand years. "If human impacts result in rates faster than we measure, it's non-sustainable," he says.

Portenga sees how this study can help managers in contested landscapes like the Chesapeake Bay. "Regulators may want to stipulate an ideal amount of sediment coming out of a river system and they may say that they want to get this back to 'normal' standards or 'normal rate.' But what is that rate? What was the erosion like before people started interacting with the landscape?" he says.

Not being able to answer that question well has contributed to many regulatory conflicts. "This work can help give a better idea of what is normal," says Portenga, who was the lead author on the study.

No Smoking Gun

This new study also goes fairly far in identifying the environmental factors -- including latitude, annual precipitation, and, especially, slope -- that drive erosion rates in drainage basins. The mechanisms controlling erosion on outcrops of bedrock are less clear.

Using several statistical tests, Portenga and Bierman were able to explain about sixty percent of what controls differing erosion rates in drainage basins around the world. But their study only explains about thirty percent of the variability between outcrops of bedrock. "This means geologists are missing a lot of the crucial information about what is controlling bedrock erosion," Portenga says.

Little-studied variables -- like the density of fractures in bedrock, the strength of rocks, and their chemistry -- may be controlling erosion rates, the study suggests.

"I don't think we'll ever find the single smoking gun of erosion," says Portenga, "the natural world is so complex and there are so many factors that contribute to how landscapes change over time. But as this method develops, we will have a better sense of what variables are important -- and which are not -- in this erosion story."

For example, it has been a truism of geology for decades that rainfall is the biggest driver of erosion. Semi-arid landscapes with little vegetation and occasional major storms were understood to have the greatest rates of erosion. But this study challenges that idea. "It turns out that the greatest control on erosion is not mean annual precipitation," says Bierman. Instead, look at slope.

"People had always thought slope was important," Beirman says, "but these data show that slope is really important."

Modeling the Future

Their new study, supported by the National Science Foundation, is part of a larger long-term goal of creating a global model that can predict the background rate and patterns of erosion across the whole planet -- and how these erosion rates will respond to changes like human-induced climate change.

"Following this study, we can start to answer big questions like, 'how does climate drive erosion?'" says Bierman. In other words, a clearer picture of what global erosion has looked like in the recent past will start to illuminate what is likely to happen in the future as human impacts and land-use decisions play out.

"We want a predictive model," says Bierman, "we want to be able to have somebody say, 'here's my drainage basin, here's the climate, here's the rock type, here's the slope, here's the mean annual precipitation: how quickly is this eroding?' That's what you need for land management."

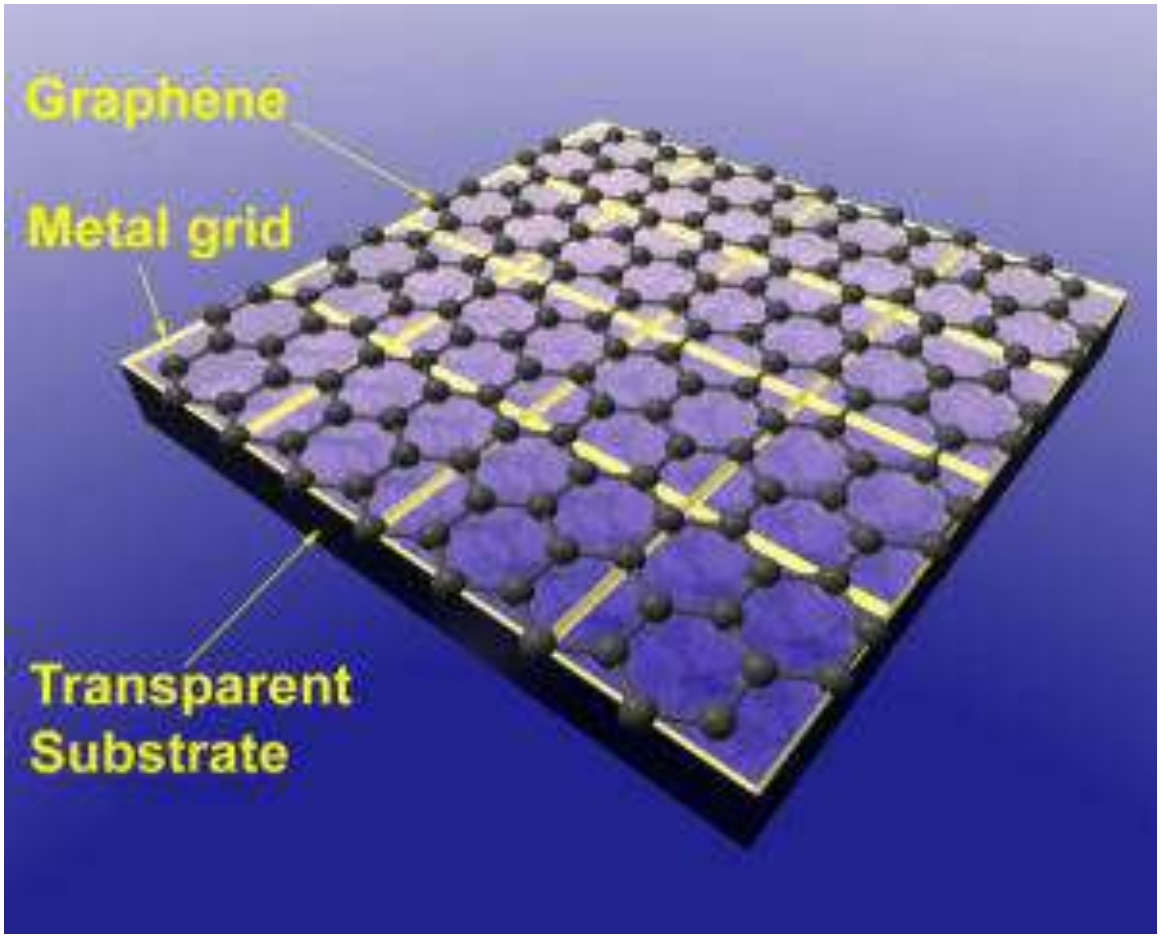
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Vermont. The original article was written by Joshua E. Brown.

Journal Reference:

1. Eric W. Portenga, Paul R. Bierman. Understanding Earth's eroding surface with ^{10}Be. *GSA Today*, 2011; 21 (8): 4 DOI: 10.1130/G111A.1

http://www.sciencedaily.com/releases/2011/07/110727161254.htm

Indium-Free Transparent, Flexible Electrodes Developed



A hybrid material that combines a fine aluminum mesh with a single-atom-thick layer of graphene outperforms materials common to current touch screens and solar cells. The transparent, flexible electrodes were developed in the lab of Rice University chemist James Tour. (Credit: Yu Zhu/Rice University)

ScienceDaily (Aug. 2, 2011) — Flexible, transparent electronics are closer to reality with the creation of graphene-based electrodes at Rice University. The lab of Rice chemist James Tour lab has created thin films that could revolutionize touch-screen displays, solar panels and LED lighting. The research was reported in the online edition of *ACS Nano.*

Flexible, see-through video screens may be the "killer app" that finally puts graphene -- the highly touted single-atom-thick form of carbon -- into the commercial spotlight once and for all, Tour said. Combined with other flexible, transparent electronic components being developed at Rice and elsewhere, the breakthrough could lead to computers that wrap around the wrist and solar cells that wrap around just about anything.

The lab's hybrid graphene film is a strong candidate to replace indium tin oxide (ITO), a commercial product widely used as a transparent, conductive coating. It's the essential element in virtually all flat-panel displays, including touch screens on smart phones and iPads, and is part of organic light-emitting diodes (OLEDs) and solar cells.

ITO works well in all of these applications, but has several disadvantages. The element indium is increasingly rare and expensive. It's also brittle, which heightens the risk of a screen cracking when a smart phone is dropped and further rules ITO out as the basis for flexible displays.

The Tour Lab's thin film combines a single-layer sheet of highly conductive graphene with a fine grid of metal nanowire. The researchers claim the material easily outperforms ITO and other competing materials, with better transparency and lower resistance to electric current.

"Many people are working on ITO replacements, especially as it relates to flexible substrates," said Tour, Rice's T.T. and W.F. Chao Chair in Chemistry as well as a professor of mechanical engineering and materials science and of computer science. "Other labs have looked at using pure graphene. It might work theoretically, but when you put it on a substrate, it doesn't have high enough conductivity at a high enough transparency. It has to be assisted in some way."

Conversely, said postdoctoral researcher Yu Zhu, lead author of the new paper, fine metal meshes show good conductivity, but gaps in the nanowires to keep them transparent make them unsuitable as stand-alone components in conductive electrodes.

But combining the materials works superbly, Zhu said. The metal grid strengthens the graphene, and the graphene fills all the empty spaces between the grid. The researchers found a grid of five-micron nanowires made of inexpensive, lightweight aluminum did not detract from the material's transparency.

"Five-micron grid lines are about a 10th the size of a human hair, and a human hair is hard to see," Tour said.

Tour said metal grids could be easily produced on a flexible substrate via standard techniques, including roll-to-roll and ink-jet printing. Techniques for making large sheets of graphene are also improving rapidly, he said; commercial labs have already developed a roll-to-roll graphene production technique.

"This material is ready to scale right now," he said.

The flexibility is almost a bonus, Zhu said, due to the potential savings of using carbon and aluminum instead of expensive ITO. "Right now, ITO is the only commercial electrode we have, but it's brittle," he said. "Our transparent electrode has better conductivity than ITO and it's flexible. I think flexible electronics will benefit a lot."

In tests, he found the hybrid film's conductivity decreases by 20 to 30 percent with the initial 50 bends, but after that, the material stabilizes. "There were no significant variations up to 500 bending cycles," Zhu said. More rigorous bending test will be left to commercial users, he said.

"I don't know how many times a person would roll up a computer," Tour added. "Maybe 1,000 times? Ten thousand times? It's hard to see how it would wear out in the lifetime you would normally keep a device."

The film also proved environmentally stable. When the research paper was submitted in late 2010, test films had been exposed to the environment in the lab for six months without deterioration. After a year, they remain so.

"Now that we know it works fine on flexible substrates, this brings the efficacy of graphene a step up to its potential utility," Tour said.

Rice graduate students Zhengzong Sun and Zheng Yan and former postdoctoral researcher Zhong Jin are co-authors of the paper.

The Office of Naval Research Graphene MURI program, the Air Force Research Laboratory through the University Technology Corporation, the Air Force Office of Scientific Research and the Lockheed Martin Corp./LANCER IV program supported the research.

story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Rice University.

Journal Reference:

1. Yu Zhu, Zhengzong Sun, Zheng Yan, Zhong Jin, James M. Tour. Rational Design of Hybrid Graphene Films for High-Performance Transparent Electrodes. *ACS Nano*, 2011; : 110729133414013 DOI: 10.1021/nn201696g

http://www.sciencedaily.com/releases/2011/08/110801142559.htm

Ancient Tides Quite Different from Today -- Some Dramatically Higher, Some Lower

Tides in the Bay of Fundy, which today are among the most extreme in the world, weren't nearly as large 5000 years ago. Top: High tide in the Bay of Fundy. Bottom: Low tide in the Bay of Fundy. (Credit: Photos courtesy of NASA)

ScienceDaily (Aug. 2, 2011) — The ebb and flow of the ocean tides, generally thought to be one of the most predictable forces on Earth, are actually quite variable over long time periods, in ways that have not been adequately accounted for in most evaluations of prehistoric sea level changes.

Due to phenomena such as ice ages, plate tectonics, land uplift, erosion and sedimentation, tides have changed dramatically over thousands of years and may change again in the future, a new study concludes.

Some tides on the East Coast of the United States, for instance, may at times in the past have been enormously higher than they are today -- a difference between low and high tide of 10-20 feet, instead of the current 3-6 foot range.

And tides in the Bay of Fundy, which today are among the most extreme in the world and have a range up to 55 feet, didn't amount to much at all about 5,000 years ago. But around that same time, tides on the southern U.S. Atlantic coast, from North Carolina to Florida, were about 75 percent higher.

The findings were just published in the *Journal of Geophysical Research*. The work was done with computer simulations at a high resolution, and supported by the National Science Foundation and other agencies.

"Scientists study past sea levels for a range of things, to learn about climate changes, geology, marine biology," said David Hill, an associate professor in the School of Civil and Construction Engineering at Oregon State University. "In most of this research it was assumed that prehistoric tidal patterns were about the same as they are today. But they weren't, and we need to do a better job of accounting for this."

One of the most interesting findings of the study, Hill said, was that around 9,000 years ago, as Earth was emerging from its most recent ice age, there was a huge amplification in tides of the western Atlantic Ocean. The tidal ranges were up to three times more extreme than those that exist today, and water would have surged up and down on the East Coast.

One of the major variables in ancient tides, of course, was sea level changes that were caused by previous ice ages. When massive amounts of ice piled miles thick in the Northern Hemisphere 15,000 to 20,000 years ago, for instance, sea levels were more than 300 feet lower.

But it's not that simple, Hill said.

"Part of what we found was that there are certain places on Earth where tidal energy gets dissipated at a disproportionately high rate, real hot spots of tidal action," Hill said. "One of these today is Hudson Bay, and it's helping to reduce tidal energies all over the rest of the Atlantic Ocean. But during the last ice age Hudson Bay was closed down and buried in ice, and that caused more extreme tides elsewhere."

Many other factors can also affect tides, the researchers said, and understanding these factors and their tidal impacts is essential to gaining a better understanding of past sea levels and ocean dynamics.

Some of this variability was suspected from previous analyses, Hill said, but the current work is far more resolved than previous studies. The research was done by scientists from OSU, the University of Leeds, University of Pennsylvania, University of Toronto, and Tulane University.

"Understanding the past will help us better predict tidal changes in the future," he said. "And there will be changes, even with modest sea level changes like one meter. In shallow waters like the Chesapeake Bay, that could cause significant shifts in tides, currents, salinity and even temperature."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Oregon State University.

http://www.sciencedaily.com/releases/2011/08/110801095116.htm

Engineers Fly World's First 'Printed' Aircraft

SULSA is the world's first 'printed' aircraft. (Credit: Project SULSA UAV)

ScienceDaily (Aug. 2, 2011) — Engineers at the University of Southampton have designed and flown the world's first 'printed' aircraft, which could revolutionise the economics of aircraft design.

The SULSA (Southampton University Laser Sintered Aircraft) plane is an unmanned air vehicle (UAV) whose entire structure has been printed, including wings, integral control surfaces and access hatches. It was printed on an EOS EOSINT P730 nylon laser sintering machine, which fabricates plastic or metal objects, building up the item layer by layer.

No fasteners were used and all equipment was attached using 'snap fit' techniques so that the entire aircraft can be put together without tools in minutes.

The electric powered vehicle aircraft, with a 2-metres wingspan, has a top speed of nearly 100 miles per hour, but when in cruise mode is almost silent. The aircraft is also equipped with a miniature autopilot developed by Dr Matt Bennett, one of the members of the team.

Laser sintering allows the designer to create shapes and structures that would normally involve costly traditional manufacturing techniques. This technology allows a highly-tailored aircraft to be developed from concept to first flight in days. Using conventional materials and manufacturing techniques, such as composites, this would normally take months. Furthermore, because no tooling is required for manufacture, radical changes to the shape and scale of the aircraft can be made with no extra cost.

This project has been led by Professors Andy Keane and Jim Scanlan from the University's Computational Engineering and Design Research group.

Professor Scanlon says: "The flexibility of the laser sintering process allows the design team to re-visit historical techniques and ideas that would have been prohibitively expensive using conventional

manufacturing. One of these ideas involves the use of a Geodetic structure. This type of structure was initially developed by Barnes Wallis and famously used on the Vickers Wellington bomber which first flew in 1936. This form of structure is very stiff and lightweight, but very complex. If it was manufactured conventionally it would require a large number of individually tailored parts that would have to be bonded or fastened at great expense."

Professor Keane adds: "Another design benefit that laser sintering provides is the use of an elliptical wing planform. Aerodynamicists have, for decades, known that elliptical wings offer drag benefits. The Spitfire wing was recognised as an extremely efficient design but it was notoriously difficult and expensive to manufacture. Again laser sintering removes the manufacturing constraint associated with shape complexity and in the SULSA aircraft there is no cost penalty in using an elliptical shape."

SULSA is part of the EPSRC-funded DECODE project, which is employing the use of leading edge manufacturing techniques, such as laser sintering, to demonstrate their use in the design of UAVs.

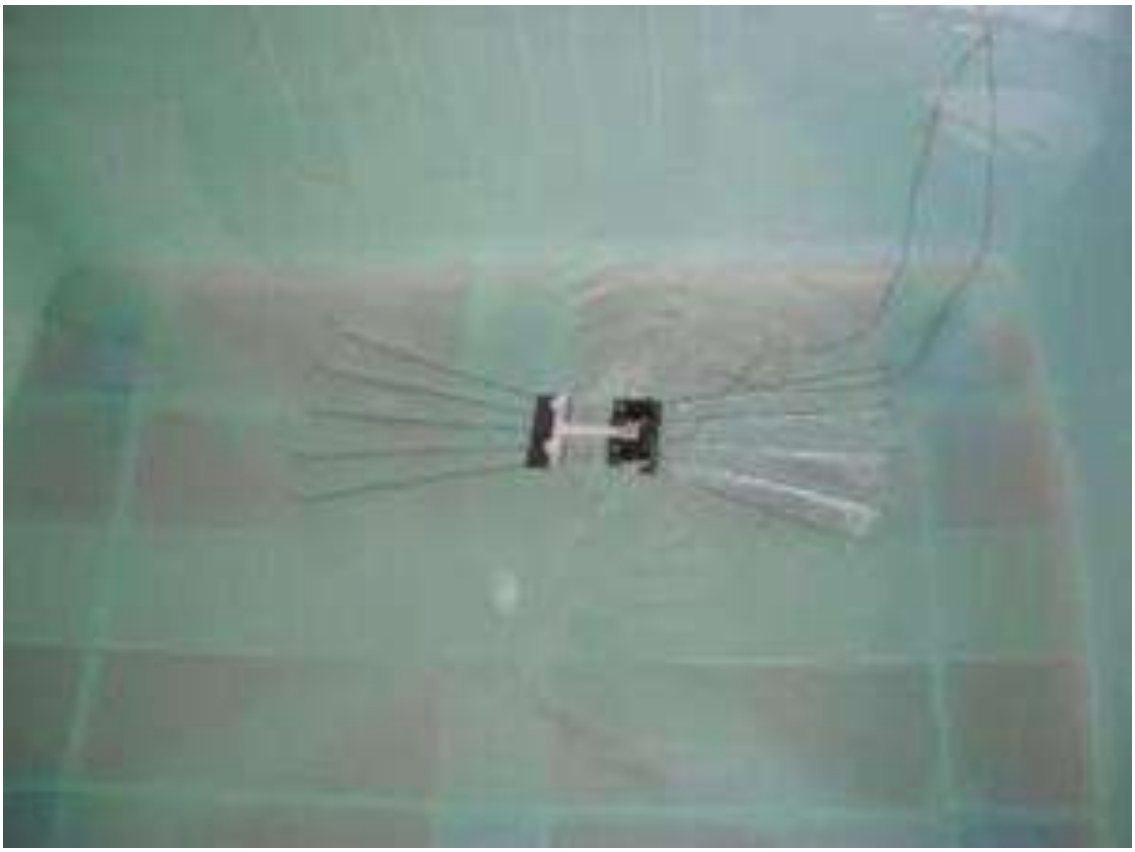
The University of Southampton has been at the forefront of UAV development since the early 1990s, when work began on the Autosub programme at its waterfront campus at the National Oceanography Centre, Southampton. A battery powered submarine travelled under sea ice in more than 300 voyages to map the North Sea, and assess herring stocks.

Now, the University is launching a ground-breaking course which enables students to take a Master's Degree in unmanned autonomous vehicle (UAV) design..

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Southampton.

http://www.sciencedaily.com/releases/2011/07/110728082326.htm

Bionic Microrobot Mimics the 'Water Strider' and Walks On Water



The water strider robot in action. (Credit: Image courtesy of American Chemical Society)

ScienceDaily (Aug. 2, 2011) — Scientists are reporting development of a new aquatic microrobot that mimics the amazing water-walking abilities of the water strider -- the long-legged insect that scoots across the surface of ponds, lakes and other waterways. The bionic microrobot incorporates improvements over previous devices of this kind that position it as a prime candidate for military spy missions, water pollution monitoring, and other applications, the scientists say.

Their study appears in the journal *ACS Applied Materials & Interfaces*.

"Walking on the water surface is a dream of humans, but it is exactly the way of life for some aquatic insects," Qinmin Pan and colleagues note, citing water striders, mosquitoes, and water spiders. This is due largely to their highly water-repellent (superhydrophobic) legs. Other scientists have made tiny aquatic devices based on the water strider with the hope of developing bionic robots that can monitor water supplies, conduct military spy missions when equipped with a camera, and perform other tasks. But until now, no one has found a way to make water-walking robots that are practical, agile, and inexpensive.

The scientists describe progress on a new robot, with a body about the size of a quarter; ten water-repellent, wire legs; and two movable, oar-like legs -- propelled by two miniature motors. "Because the weight of the microrobot is equal to that of about 390 water striders, one might expect that it will sink quickly when placed on the water surface," the report noted. However, it stands effortlessly on water surfaces and also walks and turns freely.

The authors acknowledged funding from Harbin Institute of Technology and Natural Science Foundation of China.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by American Chemical Society, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Xinbin Zhang, Jie Zhao, Qing Zhu, Ning Chen, Mingwen Zhang, Qinmin Pan. Bioinspired Aquatic Microrobot Capable of Walking on Water Surface Like a Water Strider. *ACS Applied Materials & Interfaces*, 2011; 3 (7): 2630 DOI: 10.1021/am200382g

http://www.sciencedaily.com/releases/2011/07/110727121653.htm

The Golden Years, Polished With Surgery

By ABBY ELLIN

Stephanie Diani for The New York Times

Marie Kolstad, 83, a widow who lives in Orange County, Calif., underwent a three-hour breast lift with implants.

At age 83, Marie Kolstad has a rich life. She works full time as a property manager and keeps an active social calendar, busying herself with 12 grandchildren and 13 great-grandchildren.

But one thing needed improvement, she decided: her figure. At her age, she said, "your breasts go in one direction and your brain goes in another." So on July 22, Ms. Kolstad, a widow who lives in Orange County, Calif., underwent a three-hour breast lift with implants, which costs about $8,000.

"Physically, I'm in good health, and I just feel like, why not take advantage of it?" said Ms. Kolstad. "My mother lived a long time, and I'm just taking it for granted that that will happen to me. And I want my children to be proud of what I look like."

Ms. Kolstad is one of many septuagenarians, octogenarians and even nonagenarians who are burnishing their golden years with help from the plastic surgeon. According to the American Society for Aesthetic Plastic Surgery, in 2010 there were 84,685 surgical procedures among patients age 65 and older. They included 26,635 face-lifts; 24,783 cosmetic eyelid operations; 6,469 liposuctions; 5,874 breast reductions; 3,875 forehead lifts; 3,339 breast lifts and 2,414 breast augmentations.

Except for a brief turndown during the recession, those numbers have been rising for years now, and experts say the trend seems likely to accelerate as baby boomers begin to pass age 65. But the increase also has raised concerns about safety and the propriety of performing invasive elective surgery on older patients, who may suffer unintended physical and psychological consequences.

There are as many reasons for getting plastic surgery as there are older patients, experts say. Some people are living longer and remaining healthier, and they want their physiques to align with their psyches. Some are preening for potential mates and want their feathers to look their freshest. Some are still working or looking for jobs and want to be seen as more youthful contenders.

And some are simply sick of slackened jowls, jiggly underarms and saggy eyelids. Gilbert Meyer, a retired film producer in Boynton Beach, Fla., who gave his age only as "over 75," saw Dr. Jacob Steiger, a facial plastic surgeon in Boca Raton, Fla., for an eye and neck lift last year. He spent $8,000.

"I was looking at myself in the mirror and didn't like what I was starting to see and did something about it," Mr. Meyer said. "Why not look as good as you can when you can?"

Mary Graham, a 77-year-old restaurant owner in Thomasville, Ga., got a face-lift and breast implants earlier this year. "The only time I go to the doctor is for plastic surgery," she said.

Ms. Graham plans to open another restaurant in Tallahassee, Fla., in the fall. "I work seven days a week," she said. "I wanted to look as young as I feel."

Her plastic surgeon, Dr. Daniel Man of Boca Raton, Fla., who said he is seeing increasing numbers of patients over age 70, said, "These people are healthy and want to be an active part of society."

Any operation poses risks, but surprisingly few studies have focused on older patients and cosmetic enhancements. One report, published in the journal Plastic and Reconstructive Surgery in June, found that the hazards in people over age 65 are no greater than in the younger population.

Researchers from the Cleveland Clinic reviewed the medical records of 216 face-lift patients over the course of three years. The researchers found no significant difference in the instances of minor or major complications between one group of patients whose average age was 70 and another group whose average age was 57.6.

"We're saying it's not chronologic age that's so important, but it really is physiologic," said Dr. James E. Zins, the senior author of the study and chairman of the department of plastic surgery at the Cleveland Clinic.

All patients in his study were screened for such health problems as lung and heart disease, diabetes and high blood pressure, as well as use of medications, like anticoagulants, that could have complicated the operations. But not all older patients may be so thoroughly screened, , so his findings don't necessarily mean the risks are minimal in an older population.

"Is there a theoretical age upon which complications do become more likely?" he mused. "Does that mean that patients 70 and 75 years and over can safely undergo a face-lift with the same complication rate as young patients? We didn't have enough numbers to answer that question."

While face-lifts can be performed under "conscious sedation," other reconstructive procedures typically require general anesthesia, which may be risky for an elderly patient. Older patients may take longer to heal, and the results of plastic surgery may not last as long as in younger patients, said Dr. Michael Niccole, a plastic surgeon in Newport Beach, Calif.

Some critics questions whether the benefits are worth the risks, which may be underestimated.

"You know there are biases because of the underreporting of negative findings," said James Hughes, executive director of the Institute for Ethics and Emerging Technologies, a nonprofit research group in Hartford. "The doctors have more or less financial incentives to do these procedures, and that often leads them to understate alternative kinds of treatments or medical advice."

Harriet A. Washington, author of two books about medical ethics issues, asks how older patients can give informed consent to plastic surgery when so little is known of its risks to them, especially to those with chronic conditions like diabetes, osteoporosis and heart disease.

"It's one of those things that has crept up on us, and I think, as usual, we've embraced the technology before we've really embraced the ethical questions and dimensions," she said.

And while most research indicates that people benefit psychologically from cosmetic procedures, reporting improvements in their appearance and in body image, a minority experience some kind of emotional "turbulence," said David Sarwer, an associate professor of psychology at the University of Pennsylvania School of Medicine.

"There are truly psychological repercussions to these procedures, which often aren't covered in the informed consent process," he said.

And yet: Assuming a patient is healthy, meets all of the presurgical criteria and understands that there are risks, why is it people often are squeamish about seniors going under the knife?

Nancy Etcoff, an assistant clinical professor at Harvard Medical School who studies biology and social beliefs about beauty, believes the double takes arise from our culture's mixed feelings about old people actively on the prowl. "Part of our stereotype of old people is that they are social, warm and likeable, but powerless and sexless," she said. "Here we are in the age of Viagra, which is very well accepted, but suddenly the idea of older people, mostly women, wanting to be sexually attractive at that age makes us uncomfortable.

"If an older woman wants to regain eyelids or wants a breast that she doesn't have to tuck into a waistband, then why not?"

Ms. Kolstad asked herself much the same question. "In my day, no one ever thought about breast enhancement or anything," she said. "But nowadays women go out and they would never get a second look if they show their age. I find that you have to keep up your appearance physically, even if you just want a companion or someone to ask you to dinner.

"That's not going to happen if you don't have a figure that these geezers are looking for."

http://www.nytimes.com/2011/08/09/health/09plastic.html?nl=health&emc=healthupdateema2

Sugar Doesn't Melt -- It Decomposes, Scientists Demonstrate

Flying in the face of years of scientific belief, University of Illinois researchers have demonstrated that sugar doesn't melt, it decomposes. (Credit: © milosluz / Fotolia)

ScienceDaily (Aug. 2, 2011) — Flying in the face of years of scientific belief, University of Illinois researchers have demonstrated that sugar doesn't melt, it decomposes.

"This discovery is important to food scientists and candy lovers because it will give them yummier caramel flavors and more tantalizing textures. It even gives the pharmaceutical industry a way to improve excipients, the proverbial spoonful of sugar that helps your medicine go down," said Shelly J. Schmidt, a University of Illinois professor of food chemistry.

In a presentation to the Institute of Food Technologists about the importance of the new discovery, Schmidt told the food scientists they could use the new findings to manipulate sugars and improve their products' flavor and consistency.

"Certain flavor compounds give you a nice caramel flavor, whereas others give you a burnt or bitter taste. Food scientists will now be able to make more of the desirable flavors because they won't have to heat to a 'melting' temperature but can instead hold sugar over a low temperature for a longer period of time," she said.

Candy makers will be able to use a predictable time-temperature relationship, as the dairy industry does in milk pasteurization, to achieve better results, she said.

Schmidt and graduate student Joo Won Lee didn't intend to turn an established rule of food science on its head. But they began to suspect that something was amiss when they couldn't get a constant melting point for sucrose in the work that they were doing.

"In the literature, the melting point for sucrose varies widely, but scientists have always blamed these differences on impurities and instrumentation differences. However, there are certain things you'd expect to see if those factors were causing the variations, and we weren't seeing them," Schmidt said.

The scientists determined that the melting point of sugar was heating-rate dependent.

"We saw different results depending on how quickly we heated the sucrose. That led us to believe that molecules were beginning to break down as part of a kinetic process," she said.

Schmidt said a true or thermodynamic melting material, which melts at a consistent, repeatable temperature, retains its chemical identity when transitioning from the solid to the liquid state. She and Lee used high-performance liquid chromatography to see if sucrose was sucrose both before and after "melting." It wasn't.

"As soon as we detected melting, decomposition components of sucrose started showing up," she said.

To distinguish "melting" caused by decomposition from thermodynamic melting, the researchers have coined a new name -- "apparent melting." Schmidt and her colleagues have shown that glucose and fructose are also apparent melting materials.

Another of Schmidt's doctoral students is investigating which other food and pharmaceutical materials are apparent melters. She says the list is growing every day.

Having disposed of one food science mystery, Schmidt plans to devote time to others. For instance, staling intrigues her. "We could ship a lot more food around the world if we could stabilize it, keep it from getting stale," she said.

Or there's hydrate formation, which can make drink mixes clumpy if they're open for a while. "We've observed the results -- clumping under conditions of low relative humidity -- but we really don't know why it happens," she noted.

Schmidt said that new instruments are making it possible to probe some of the processes scientists have taken for granted in a way they couldn't do before.

Four studies describing Schmidt's research have been published in recent issues of the *Journal of Agricultural and Food Chemistry*. Co-authors of the first, third, and fourth articles are Joo Won Lee of the U of I and Leonard C. Thomas of DSC Solutions. Joo Won Lee, John Jerrell, Hao Feng, and Keith Cadwallader, all of the U of I, and Leonard C. Thomas of DSC Solutions co-authored the second article.

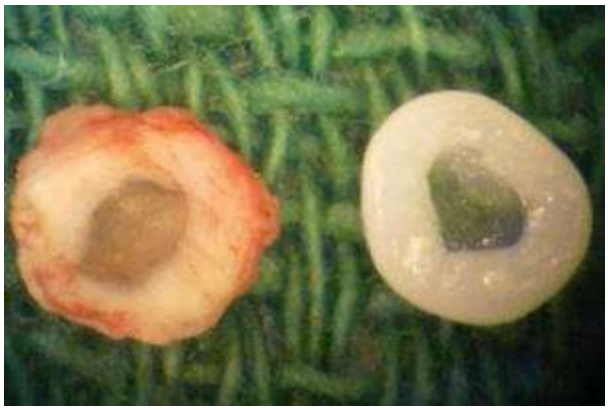
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Illinois College of Agricultural, Consumer and Environmental Sciences. The original article was written by Phyllis Picklesimer.

Journal Reference:

1. Joo Won Lee, Leonard C. Thomas, Shelly J. Schmidt. Can the Thermodynamic Melting Temperature of Sucrose, Glucose, and Fructose Be Measured Using Rapid-Scanning Differential Scanning Calorimetry (DSC)? *Journal of Agricultural and Food Chemistry*, 2011; 59 (7): 3306 DOI: 10.1021/jf104852u

http://www.sciencedaily.com/releases/2011/07/110725123549.htm

In the Battle to Relieve Back Aches, Researchers Create Bioengineered Spinal Disc Implants



From left, a natural rat IVD compared with a tissue engineered IVD. (Credit: Bonassar lab)

ScienceDaily (Aug. 1, 2011) — Every year, millions of people contend with lower back and neck discomfort. With intent to ease their pain, Cornell University engineers in Ithaca and doctors at the Weill Cornell Medical College in New York City have created a biologically based spinal implant that could someday spell relief for these countless sufferers.

Lawrence Bonassar, Ph.D., associate professor of biomedical engineering and mechanical engineering, and Roger Härtl, M.D., associate professor of neurosurgery at Weill Cornell Medical College and chief of spinal surgery at NewYork-Presbyterian Hospital/Weill Cornell Medical Center, have created bioengineered spinal discs that have been successfully implanted and tested in animals.

The other scientists on the paper are Robby Bowles, Cornell Ph.D. '11, and Harry Gebhard, M.D., of Weill Cornell Medical College.

Their research will be published online Aug. 1, 2011 in the *Proceedings of the National Academy of Sciences*.

"We've engineered discs that have the same structural components and behave just like real discs," says Bonassar. "The hope is that this promising research will lead to engineered discs that we can implant into patients with damaged discs."

Each year, 40 percent to 60 percent of American adults suffer from chronic back or neck pain. For patients diagnosed with severe degenerative disc disease, or herniated discs, neurosurgeons perform surgery called discectomy -- removing the spinal disc -- followed by a fusion of the vertebrate bones to stabilize the spine. In spite of the surgery, the patient's back will likely not feel the same as before their injury.

"The surgery prevents pain, but often limits mobility, which may hinder someone who has an active lifestyle or even end the career of a professional athlete," says Härtl, who is also the team neurosurgeon for the New York Giants.

Human discs look something like a tire, with the outer part, called the annulus, made of a stiff material, and the inner circle, the nucleus, made of a gel-like substance that gets pressurized and bears weight.

Bonassar's lab, which focuses on the regeneration and analysis of musculoskeletal tissue, engineered artificial discs out of two polymers -- collagen, which wraps around the outside, and a hydrogel called alginate in the middle. They seeded the implants with cells that repopulate the structures with new tissue. Remarkably, as

opposed to artificial implants today that degrade over time, the scientists are seeing that the implants get better as they mature in the body, due to the growth of the cells.

"Our implants have maintained 70 to 80 percent of initial disc height. In fact, the mechanical properties get better with time," says Bonassar.

The implants would treat a broad category of illness called degenerative disc disease -- a leading cause of disability worldwide. According to Härtl, an increasing number of patients need treatment or surgery from the degeneration of the intervertebral disc. A surgical procedure approved by the FDA in 2005 involves removing the disc completely and replacing it with an implant made of a combination of metal and plastic, with the aim of mimicking the normal movement of the lumbar and spine.

"Bone or metal or plastic implants are complicated structures which come with a mechanical risk of the structures moving around, or debris from the metal or plastic particles accumulating in the body from wear and tear," says Härtl.

From a biological perspective, the new discs could create a "huge advantage" over traditional implants because of how they integrate and mature with the vertebrae. This major surgery would become less invasive, safer and come with fewer long-term side effects, he says.

The scientists began collaborating on the project in 2006, first funded by an Ithaca-Weill seed grant. Since then, the project has moved into animal testing stages, and it has received several awards and accolades, including a $325,000 grant from Switzerland's AO Spine foundation and $100,000 in support from NFL Charities.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Cornell University. The original article was written by Anne Ju.

Journal Reference:

1. Robby D. Bowles, Harry H. Gebhard, Roger Härtl, Lawrence J. Bonassar. Tissue-engineered intervertebral discs produce new matrix, maintain disc height, and restore biomechanical function to the rodent spine. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1107094108

http://www.sciencedaily.com/releases/2011/08/110801160152.htm

Microbes Consumed Oil in Gulf Slick at Unexpected Rates, Study Finds

A new technique for determing the concentration of oxygen in a liquid sample uses a laser (coming from the green fiber, right) and an oxygen-sensitive sticker called an optode (pale spot) inside the sample bottle. When struck by the laser, the sticker fluoresces; the wavelength of the light it gives off indicates the concentration of oxygen in the fluid around it. WHOI chemist Ben Van Mooy used this method to monitor microbial activity in samples of water taken from within and outside the oil slick on the surface of the Gulf of Mexico after the Deepwater Horizon oil spill. (Credit: Photo by Tom Kleindinst, Woods Hole Oceanographic Institution)

ScienceDaily (Aug. 1, 2011) — More than a year after the largest oil spill in history, perhaps the dominant lingering question about the Deepwater Horizon spill is, "What happened to the oil?" Now, in the first published study to explain the role of microbes in breaking down the oil slick on the surface of the Gulf of Mexico, Woods Hole Oceanographic Institution (WHOI) researchers have come up with answers that represent both surprisingly good news and a head-scratching mystery.

In research scheduled to be published in the Aug. 2 online edition of *Environmental Research Letters*, the WHOI team studied samples from the surface oil slick and surrounding Gulf waters. They found that bacterial microbes inside the slick degraded the oil at a rate five times faster than microbes outside the slick -- accounting in large part for the disappearance of the slick some three weeks after Deepwater Horizon's Macondo well was shut off.

At the same time, the researchers observed no increase in the number of microbes inside the slick -- something that would be expected as a byproduct of increased consumption, or respiration, of the oil. In this process, respiration combines food (oil in this case) and oxygen to create carbon dioxide and energy.

"What did they do with the energy they gained from this increased respiration?" asked WHOI chemist Benjamin Van Mooy, senior author of the study. "They didn't use it to multiply. It's a real mystery," he said.

Van Mooy and his team were nearly equally taken aback by the ability of the microbes to chow down on the oil in the first place. Going into the study, he said, "We thought microbe respiration was going to be minimal." This was because nutrients such as nitrogen and phosphorus -- usually essential to enable microbes to grow and make new cells -- were scarce in the water and oil in the slick. "We thought the microbes would not be able to respond," Van Mooy said.

But the WHOI researchers found, to the contrary, that the bacteria not only responded, but did so at a very high rate. They discovered this by using a special sensor called an oxygen optode to track the changing oxygen levels in water samples taken from the slick. If the microbes were respiring slowly, then oxygen levels would decrease slowly; if they respired quickly, the oxygen would decrease quickly.

"We found that the answer was 'quick,'" Van Mooy said. "By a lot."

Bethanie Edwards, a biochemist in Van Mooy's lab and lead author of the paper, said she too was "very surprised" by the amount of oil consumption by the microbes. "It's not what we expected to see." She added that she was also "a little afraid" that oil companies and others might use the results to try to convince the public that spills can do relatively little harm. "They could say, 'Look, we can put oil into the environment and the microbes will eat it,'" she said.

Edwards, a graduate student in the joint MIT/WHOI program, pointed out that this is not completely the case, because oil is composed of a complex mixture molecules, some of which the microbes are unable to break down.

"Oil is still detrimental to the environment, " she said, "because the molecules that are not accessible to microbes persist and could have toxic effects." These are the kinds of molecules that can get into the food web of both offshore and shoreline environments, Edwards and Van Mooy said. In addition, Edwards added, the oil that is consumed by microbes "is being converted to carbon dioxide that still gets into the atmosphere."

Follow-up studies already "are in place," Van Mooy says, to address the "mysterious" finding that the oil-gorging microbes do not appear to manufacture new cells. If the microbes were eating the oil at such a high rate, what did they do with the energy? Van Mooy, Edwards, and their colleagues hypothesize that they may convert the energy to some other molecule, like sugars or fats. They plan to use "state-of-the-art methods" under development in their laboratory to look for bacterial fat molecules, a focus of Van Mooy's previous work. The results, he says, "could show where the energy went."

Van Mooy said he isn't sure exactly what fraction of the oil loss in the spill is due to microbial consumption; other processes, including evaporation, dilution, and dispersion, might have contributed to the loss of the oil slick. But the five-fold increase in the microbe respiration rate suggests it contributed significantly to the oil breakdown. "Extrapolating our observations to the entire area of the oil slick supports the assertion microbes had the potential to degrade a large fraction of the oil as it arrived at the surface from the well," the researchers say in their paper.

"This is the first published study to put numbers on the role of microbes in the degradation of the oil slick," said Van Mooy. "Our study shows that the dynamic microbial community of the Gulf of Mexico supported remarkable rates of oil respiration, despite a dearth of dissolved nutrients," the researchers said.

Edwards added that the results suggest "that microbes had the metabolic potential to break down a large portion of hydrocarbons and keep up with the flow rate from the wellhead."

Also participating in the study from WHOI were researchers Christopher M. Reddy, Richard Camilli, Catherine A. Carmichael, and Krista Longnecker.

The research was supported by RAPID grants from the National Science Foundation.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Woods Hole Oceanographic Institution.

Journal Reference:

1. Bethanie Edwards, Christopher Reddy, Richard Camilli, Catherine Carmichael, Krista Longnecker, Benjamin Van Mooy. Rapid microbial respiration of oil from the Deepwater Horizon spill in offshore surface waters of the Gulf of Mexico. *Environmental Research Letters*, November 2011 (forthcoming)

http://www.sciencedaily.com/releases/2011/08/110801111752.htm

Oxygen Molecules Found in Nearby Star-Forming Cloud

This dramatic image offers a peek inside a 'cavern' of dust and gas where thousands of stars are forming. The image, taken by the Advanced Camera for Surveys (ACS) aboard NASA's Hubble Space Telescope, represents the sharpest view ever taken of this region, called the Orion Nebula. More than 3000 stars of various sizes appear in this image. Some of them have never been seen in visible light. (Credit: NASA, ESA, M. Robberto (Space Telescope Science Institute/ESA) and the Hubble Space Telescope Orion Treasury Project Team)

ScienceDaily (Aug. 1, 2011) — The European Space Agency's Herschel space observatory has found molecules of oxygen in a nearby star-forming cloud. This is the first undisputed detection of oxygen molecules in space. It concludes a long search but also leaves questions unanswered.

The oxygen molecules have been found in the nearby Orion star-forming complex. While atomic oxygen has been long known in warm regions of space, previous missions looking for the molecular variety -- two atoms of oxygen bonded together -- came up largely empty-handed.

Even the observed amount of atomic oxygen is far less than that expected and this created an oxygen 'accounting problem' that can be roughly voiced as "where is all the oxygen hiding in the cold clouds?"

NASA's Submillimetre Wave Astronomy Satellite and Sweden's Odin mission have both searched for molecular oxygen and established that its abundance is dramatically lower than expected.

One possibility put forward to explain this was that oxygen atoms freeze onto tiny dust grains found floating in space and are converted to water ice, effectively removing them from sight.

If this is true, the ice should evaporate in warmer regions of the cosmos, returning water to the gas and allowing molecular oxygen to form and to be seen.

Paul Goldsmith, NASA's Herschel project scientist at NASA's Jet Propulsion Laboratory, Pasadena, California, and an international team of investigators went looking for it with Herschel.

They used Herschel's HIFI far-infrared instrument and targeted Orion, where they reasoned that the forming stars would heat the surrounding gas and dust.

Using three infrared frequencies of the instrument, the Herschel Oxygen Project team were successful. They found there to be one molecule of oxygen for every million hydrogen molecules.

"This explains where some of the oxygen might be hiding," said Dr Goldsmith. "But we didn't find large amounts of it, and still don't understand what is so special about the spots where we find it. The Universe still holds many secrets."

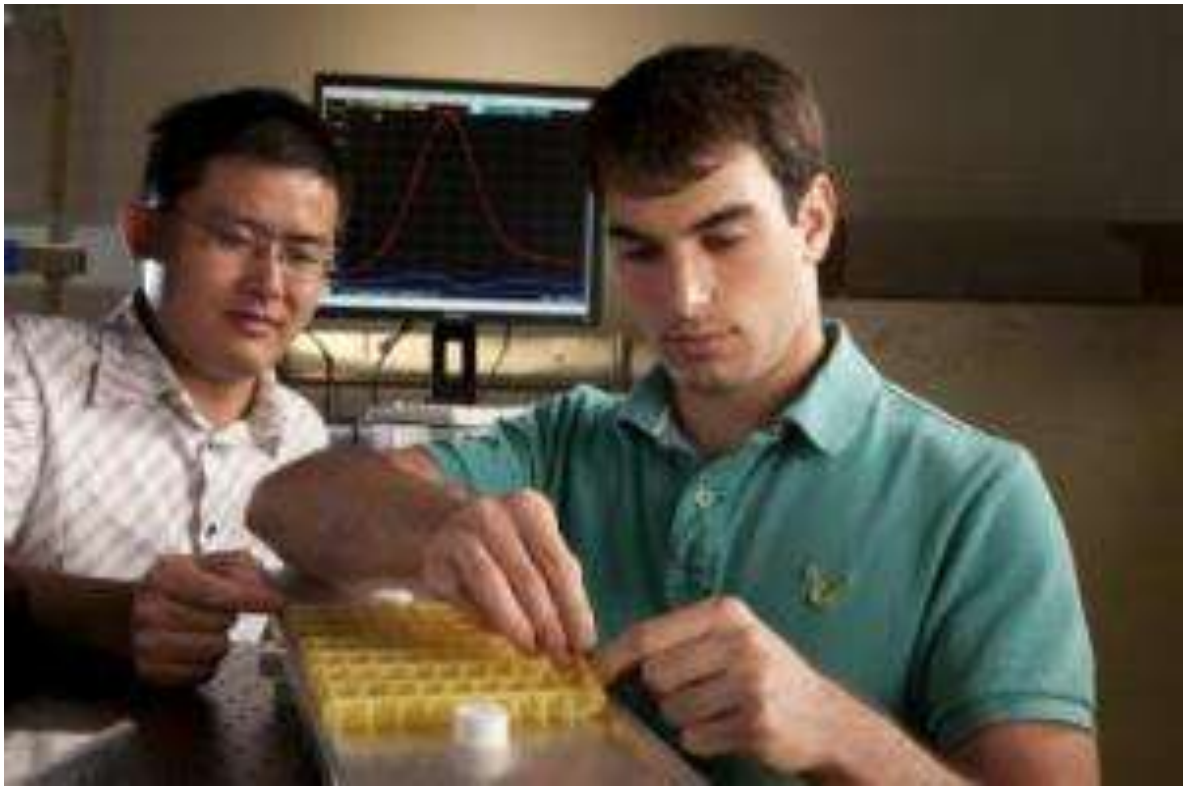
Oxygen, in all its forms, is the third most abundant element in the Universe and a major ingredient of our planet. It is found in our atmosphere, oceans and rocks, and is critical for life itself because we breathe the molecular form.

Although the search continues for it in space, Göran Pilbratt, ESA's Herschel Project Scientist, believes this is a breakthrough moment: "Thanks to Herschel, we now have an undisputed confirmation that molecular oxygen is definitely out there. There are still many open questions but Herschel's superior capabilities now enables us to address these riddles."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by European Space Agency (ESA).

http://www.sciencedaily.com/releases/2011/08/110801121904.htm

Manipulating Light at Will: Research Could Help Replace Electronic Components With Optical Technology



This is Alec Rose and Da Huang of Duke University. (Credit: Duke University Photography)

ScienceDaily (Aug. 1, 2011) — Electrical engineers at Duke University have developed a material that allows them to manipulate light in much the same way that electronics manipulate flowing electrons.

The researchers say the results of their latest proof-of-concept experiments could lead to the replacement of electrical components with those based on optical technologies. Light-based devices would enable faster and more efficient transmission of information, much in the same way that replacing wires with optical fibers revolutionized the telecommunications industry.

The breakthrough revolves around a novel artificial structure known as a metamaterial. These exotic composite materials are not so much a single substance, but an entire structure that can be engineered to exhibit properties not readily found in nature. The structure used in these experiments resembles a miniature set of tan Venetian blinds.

When light passes through a material, even though it may be reflected, refracted or weakened along the way, it is still the same light coming out. This is known as linearity.

"For highly intense light, however, certain 'nonlinear' materials violate this rule of thumb, converting the incoming energy into a brand new beam of light at twice the original frequency, called the second-harmonic," said Alec Rose, graduate student in the laboratory of David R. Smith, William Bevan Professor of electrical and computer engineering at Duke's Pratt School of Engineering.

As an example, he cited the crystal in some laser pointers, which transforms the normal laser light into another beam of a different color, which would be the second-harmonic. Though they contain nonlinear properties, designing such devices requires a great deal of time and effort to be able to control the direction of the second harmonic, and natural nonlinear materials are quite weak, Rose said.

"Normally, this frequency-doubling process occurs over a distance of many wavelengths, and the direction in which the second-harmonic travels is strictly determined by whatever nonlinear material is used," Rose said. "Using the novel metamaterials at microwave frequencies, we were able to fabricate a nonlinear device capable of 'steering' this second-harmonic. The device simultaneously doubled and reflected incoming waves in the direction we wanted."

The research results were published online in the journal *Physical Review Letters*. It was supported by the Air Force Office of Scientific Research. Smith's team was the first to demonstrate that similar metamaterials could act as a cloaking device in 2006 and a next generation lens in 2009.

"This magnitude of control over light is unique to nonlinear metamaterials, and can have important consequences in all-optical communications, where the ability to manipulate light is crucial," Rose said.

The device, which measures six inches by eight inches and about an inch high, is made of individual pieces of the same fiberglass material used in circuit boards arranged in parallel rows. Each piece is etched with copper circles. Each copper circle has a tiny gap that is spanned by a diode, which when excited by light passing through it, breaks its natural symmetry, creating non-linearity.

"The trend in telecommunications is definitely optical," Rose said. "To be able to control light in the same manner that electronics control currents will be an important step in transforming telecommunications technologies."

Duke graduate student Da Huang was also a member of the team.

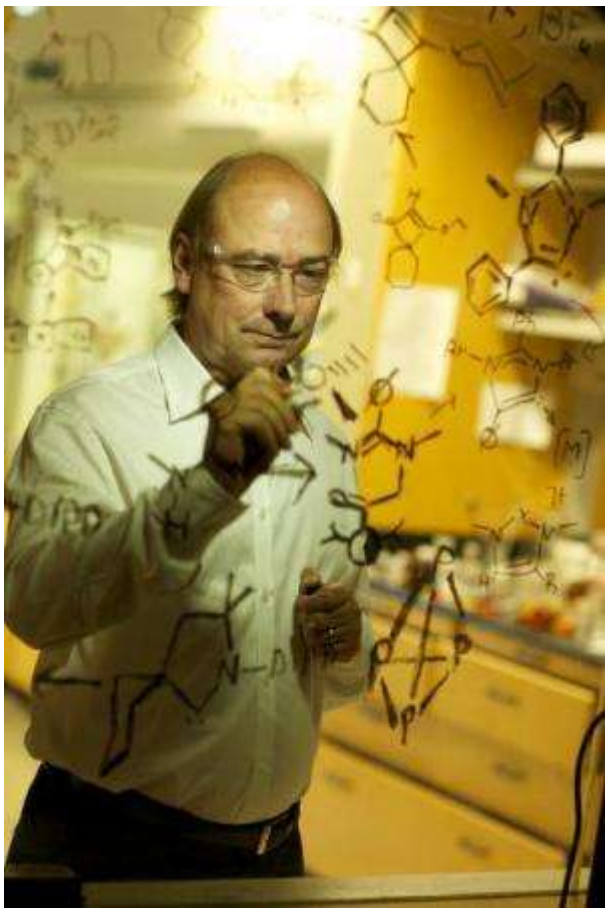
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Duke University, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Alec Rose, Da Huang, David R. Smith. Controlling the Second Harmonic in a Phase-Matched Negative-Index Metamaterial. *Physical Review Letters*, 2011; DOI: 10.1103/PhysRevLett.107.063902

http://www.sciencedaily.com/releases/2011/08/110801105659.htm

Chemists Transform Acids Into Bases: Research Offers Vast Family of New Catalysts for Use in Drug Discovery, Biotechnology



Guy Bertrand is a distinguished professor of chemistry at UC Riverside. (Credit: L. Duka.)

ScienceDaily (Aug. 1, 2011) — Chemists at the University of California, Riverside have accomplished in the lab what until now was considered impossible: transform a family of compounds which are acids into bases.

As our chemistry lab sessions have taught us, acids are substances that taste sour and react with metals and bases (bases are the chemical opposite of acids). For example, compounds of the element boron are acidic while nitrogen and phosphorus compounds are basic.

The research, reported in the July 29 issue of *Science*, makes possible a vast array of chemical reactions -- such as those used in the pharmaceutical and biotechnology industries, manufacturing new materials, and research academic institutions.

"The result is totally counterintuitive," said Guy Bertrand, a distinguished professor of chemistry, who led the research. "When I presented preliminary results from this research at a conference recently, the audience was incredulous, saying this was simply unachievable. But we have achieved it. We have transformed boron compounds into nitrogen-like compounds. In other words, we have made acids behave like bases."

Bertrand's lab at UC Riverside specializes on catalysts. A catalyst is a substance -- usually a metal to which ions or compounds are bound -- that facilitates or allows a chemical reaction, but is neither consumed nor

altered by the reaction itself. Crucial to the reaction's success, a catalyst is like the car engine enabling an uphill drive. While only about 30 metals are used to form catalysts, the binding ions or molecules, called ligands, can number in the millions, allowing for numerous catalysts. Currently, the majority of these ligands are nitrogen- or phosphorus-based.

"The trouble with using phosphorus-based catalysts is that phosphorus is toxic and it can contaminate the end products," Bertrand said. "Our work shows that it is now possible to replace phosphorus ligands in catalysts with boron ligands. And boron is not toxic. Catalysis research has advanced in small, incremental steps since the first catalytic reaction took place in 1902 in France. Our work is a quantum leap in catalysis research because a vast family of new catalysts can now be added to the mix. What kind of reactions these new boron-based catalysts are capable of facilitating is as yet unknown. What is known, though, is that they are potentially numerous."

Bertrand explained that acids cannot be used as ligands to form a catalyst. Instead, bases must be used. While all boron compounds are acids, his lab has succeeded in making these compounds behave like bases. His lab achieved the result by modifying the number of electrons in boron, with no change to the atom's nucleus.

"It's almost like changing one atom into another atom," Bertrand said.

His research group stumbled upon the idea during one of its regular brainstorming meetings.

"I encourage my students and postdoctoral researchers to think outside the box and not be inhibited or intimidated about sharing ideas with the group," he said. "The smaller these brainstorming groups are, the freer the participants feel about bringing new and unconventional ideas to the table, I have found. About 90 percent of the time, the ideas are ultimately not useful. But then, about 10 percent of the time we have something to work with."

The research was supported by grants to Bertrand from the National Science Foundation and the U.S. Department of Energy.

An internationally renowned scientist, Bertrand came to UCR in 2001 from France's national research agency, the Centre National de la Recherche Scientifique (CNRS). He is the director of the UCR-CNRS Joint Research Chemistry Laboratory.

A recipient of numerous awards and honors, most recently he won the 2009-2010 Sir Ronald Nyholm Prize for his seminal research on the chemistry of phosphorus-phosphorus bonds and the chemistry of stable carbenes and their complexes.

He is a recipient of the Japanese Society for Promotion of Science Award, the Humboldt Award, the International Council on Main Group Chemistry Award, and the Grand Prix Le Bel of the French Chemical Society. He is a fellow of the American Association for the Advancement of Sciences, and a member of the French Academy of Sciences, the European Academy of Sciences, Academia Europea, and Academies des Technologies.

He has authored more than 300 scholarly papers and holds 35 patents.

Bertrand was joined in the research by Rei Kinjo and Bruno Donnadieu of UCR; and Mehmet Ali Celik and Gernot Frenking of Philipps-Universitat Marburg, Germany.

UCR's Office of Technology Commercialization has filed a provisional patent application on the boron-based ligands developed in Bertrand's lab.

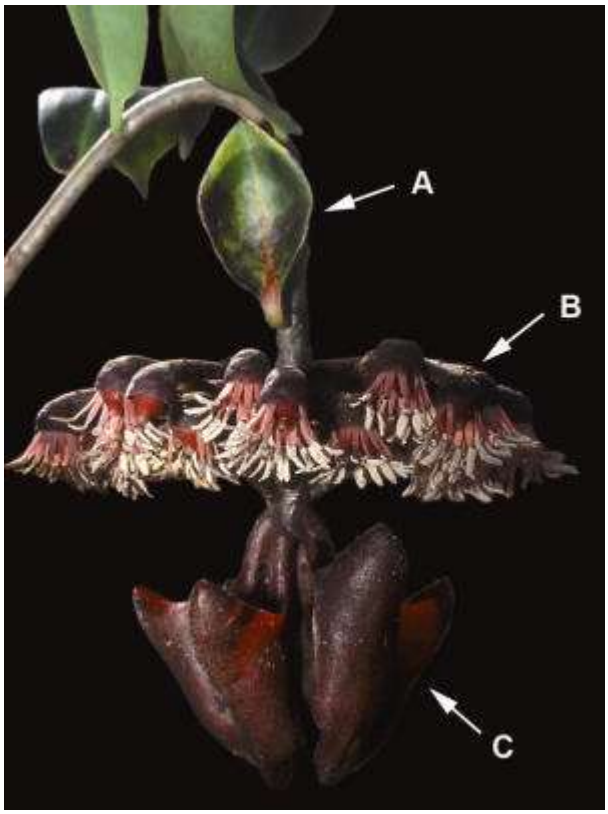
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of California - Riverside.

Journal Reference:

1. R. Kinjo, B. Donnadieu, M. A. Celik, G. Frenking, G. Bertrand. Synthesis and Characterization of a Neutral Tricoordinate Organoboron Isoelectronic with Amines. *Science*, 2011; 333 (6042): 610 DOI: 10.1126/science.1207573

http://www.sciencedaily.com/releases/2011/07/110728144721.htm

Rainforest Plant Developed 'Sonar Dish' to Attract Pollinating Bats



Flowering inflorescence of Marcgravia evenia. (A) dish-shaped leaf, (B) ring of flowers most of them in the male phase with anthers shedding pollen, (C) cup-like nectaries. (Credit: Image © Ralph Mangelsdorff)

ScienceDaily (Aug. 1, 2011) — How plants sound as well as how they look helps them to attract pollinators, a new study by scientists at the University of Bristol, UK, and the Universities of Erlangen and Ulm, Germany has found.

The researchers discovered that a rainforest vine, pollinated by bats, has evolved dish-shaped leaves with such conspicuous echoes that nectar-feeding bats can find its flowers twice as fast by echolocation. The study is published in *Science*.

While it is well known that the bright colours of flowers serve to attract visually-guided pollinators such as bees and birds, little research has been done to see whether plants which rely on echolocating bats for pollination and seed dispersal have evolved analogous echo-acoustic signals.

The Cuban rainforest vine Marcgravia evenia has developed a distinctively shaped concave leaf next to its flowers which, the researchers noticed, is reminiscent of a dish reflector. By analyzing the leaf's acoustic reflection properties, they found that it acts as an ideal echo beacon, sending back strong, multidirectional echoes with an easily recognizable, and unvarying acoustic signature -- perfect for making the flower obvious to echolocating bats.

They then trained nectar-feeding bats (*Glossophaga soricina*) to search for a single small feeder hidden within an artificial foliage background, varying the feeder's position and measuring the time the bats took to find it. The feeder was presented on its own or with a replica of either a foliage leaf or the distinctive dish-shaped

leaf. Each feeder type was randomly tested once at each of the 64 positions within the artificial foliage background.

Search times were longest for all bats when the feeder was presented on its own and were slightly, but not significantly, shorter when a replica of a foliage leaf was added. However, a dish-shaped leaf replica above the feeder always reduced search times -- by around 50 per cent.

Although the leaf's unusual shape and orientation reduce its photosynthetic yield compared to a similarly sized foliage leaf, the researchers argue that these costs are outweighed by the benefits of more efficient pollinator attraction.

Dr Marc Holderied of Bristol's School of Biological Sciences, co-author of the paper, said: "This echo beacon has benefits for both the plant and the bats. On one hand, it increases the foraging efficiency of nectar-feeding bats, which is of particular importance as they have to pay hundreds of visits to flowers each night to fulfill their energy needs. On the other hand, the M. evenia vine occurs in such low abundance that it requires highly mobile pollinators."

Bats, with their wide home range and excellent spatial memory, are exceptionally efficient pollinators and many other neotropical plants depend on them for pollination. As the acoustic and perceptual principles shaping the echo beacon leaf of Marcgravia evenia should work for all echolocating pollinators, the researchers expect to find other instances of plant species that use acoustic signalling to attract their bat pollinators.

story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Bristol, via EurekAlert!, a service of AAAS.

Journal Reference:

1. R. Simon, M. W. Holderied, C. U. Koch, O. von Helversen. Floral Acoustics: Conspicuous Echoes of a Dish-Shaped Leaf Attract Bat Pollinators. *Science*, 2011; 333 (6042): 631 DOI: 10.1126/science.1204210

http://www.sciencedaily.com/releases/2011/07/110728144717.htm

Elliptical Galaxies Are Not Dead

The NGC 5557 galaxy (the subject of the publication), clearly shows the new stellar structures discovered by the MégaCam camera of the Canada-France-Hawaii Telescope (Credit: © Duc/CFHT, CNRS/CNRC/University of Hawaii)

ScienceDaily (Aug. 1, 2011) — Initial results from research carried out as part of the Atlas3D project on two elliptical galaxies could, if they are confirmed, call into question the current model of the formation of galaxies.

An international team of astronomers, including in particular CNRS, CEA, the CFHT, the Observatoire de Lyon, ENS de Lyon and Claude Bernard Lyon 1 et Paris-Diderot universities, are due to publish their initial observations in the journal *Monthly Notices of The Royal Astronomical Society.*

Current models explain elliptical galaxies as "dead" galaxies: the relative age of their stars ranges between 7 and 10 billion years and the observed lack of gas precludes the formation of new stars. However, a completely different history is suggested by the images of two galaxies obtained by the MégaCam camera of the Canada-France-Hawaii Telescope (CFHT, CNRS/CNRC/University of Hawaii).

The researchers,* all members of an international Atlas3D team, have shown that these two elliptical galaxies were formed from the "merger" of two large spiral galaxies, just 1 to 3 billion years ago. During this major event, part of the matter of the galaxies in "collision" was ejected and formed stellar debris. The filaments of gas and stars, which have been detected by the CFHT, form two long tails on either side of the galaxy, extending over more than one million light years (more than 10 times the span of the Milky Way). It is the largest stellar structure ever detected, although it has not been revealed before due to the low surface brightness and considerable spread of its filaments. These filamentary structures were formed during encounters between spiral galaxies, by a gravitational mechanism similar to that of oceanic tides, hence their name of "tidal tails."

The Atlas3D team is conducting a deep optical imaging program on a hundred or so other nearby elliptical galaxies. If the results obtained on these first two galaxies are confirmed and if such extended stellar structures prove to be frequent, the standard model of the formation of elliptical galaxies needs to be revised.

*In France, the laboratories involved are the Laboratoire Astrophysique, Instrumentation et Modélisation (CNRS/CEA/Université Paris Diderot), the Centre de Recherche Astrophysique de Lyon (CNRS/ENS de Lyon/Université Lyon1), working in collaboration with the CFHT (Canada-France-Hawaii Telescope).

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by CNRS (Délégation Paris Michel-Ange).

Journal Reference:

1. Pierre-Alain Duc, Jean-Charles Cuillandre, Paolo Serra, Leo Michel-Dansac, Etienne Ferriere, Katherine Alatalo, Leo Blitz, Maxime Bois, Frederic Bournaud, Martin Bureau, Michele Cappellari, Roger L. Davies, Timothy A. Davis, P. T. de Zeeuw, Eric Emsellem, Sadegh Khochfar, Davor Krajnovi'c, Harald Kuntschner, Pierre-Yves Lablanche, Richard M. McDermid, Raffaella Morganti, Thorsten Naab, Tom Oosterloo, Marc Sarzi, Nicholas Scott, Anne-Marie Weijmans, and Lisa M. Young. The Atlas3D project: the merger origin of a fast and a slow rotating Early-Type Galaxy revealed with deep optical imaging: first results. *Monthly Notices of The Royal Astronomical Society*, 2011 (in press)

http://www.sciencedaily.com/releases/2011/07/110726093156.htm

Sun-Free Photovoltaics: Materials Engineered to Give Off Precisely Tuned Wavelengths of Light When Heated

A variety of silicon chip micro-reactors developed by the MIT team. Each of these contains photonic crystals on both flat faces, with external tubes for injecting fuel and air and ejecting waste products. Inside the chip, the fuel and air react to heat up the photonic crystals. In use, these reactors would have a photovoltaic cell mounted against each face, with a tiny gap between, to convert the emitted wavelengths of light to electricity. (Credit: Photo by Justin Knight)

ScienceDaily (July 31, 2011) — A new photovoltaic energy-conversion system developed at MIT can be powered solely by heat, generating electricity with no sunlight at all. While the principle involved is not new, a novel way of engineering the surface of a material to convert heat into precisely tuned wavelengths of light -- selected to match the wavelengths that photovoltaic cells can best convert to electricity -- makes the new system much more efficient than previous versions.

The key to this fine-tuned light emission, described in the journal *Physical Review A*, lies in a material with billions of nanoscale pits etched on its surface. When the material absorbs heat -- whether from the sun, a hydrocarbon fuel, a decaying radioisotope or any other source -- the pitted surface radiates energy primarily at these carefully chosen wavelengths.

Based on that technology, MIT researchers have made a button-sized power generator fueled by butane that can run three times longer than a lithium-ion battery of the same weight; the device can then be recharged instantly, just by snapping in a tiny cartridge of fresh fuel. Another device, powered by a radioisotope that steadily produces heat from radioactive decay, could generate electricity for 30 years without refueling or servicing -- an ideal source of electricity for spacecraft headed on long missions away from the sun.

According to the U.S. Energy Information Administration, 92 percent of all the energy we use involves converting heat into mechanical energy, and then often into electricity -- such as using fuel to boil water to turn a turbine, which is attached to a generator. But today's mechanical systems have relatively low efficiency, and can't be scaled down to the small sizes needed for devices such as sensors, smartphones or medical monitors.

"Being able to convert heat from various sources into electricity without moving parts would bring huge benefits," says Ivan Celanovic ScD '06, research engineer in MIT's Institute for Soldier Nanotechnologies (ISN), "especially if we could do it efficiently, relatively inexpensively and on a small scale."

It has long been known that photovoltaic (PV) cells needn't always run on sunlight. Half a century ago, researchers developed thermophotovoltaics (TPV), which couple a PV cell with any source of heat: A burning hydrocarbon, for example, heats up a material called the thermal emitter, which radiates heat and light onto the PV diode, generating electricity. The thermal emitter's radiation includes far more infrared wavelengths

than occur in the solar spectrum, and "low band-gap" PV materials invented less than a decade ago can absorb more of that infrared radiation than standard silicon PVs can. But much of the heat is still wasted, so efficiencies remain relatively low.

An ideal match

The solution, Celanovic says, is to design a thermal emitter that radiates only the wavelengths that the PV diode can absorb and convert into electricity, while suppressing other wavelengths. "But how do we find a material that has this magical property of emitting only at the wavelengths that we want?" asks Marin Soljačić, professor of physics and ISN researcher. The answer: Make a photonic crystal by taking a sample of material and create some nanoscale features on its surface -- say, a regularly repeating pattern of holes or ridges -- so light propagates through the sample in a dramatically different way.

"By choosing how we design the nanostructure, we can create materials that have novel optical properties," Soljačić says. "This gives us the ability to control and manipulate the behavior of light."

The team -- which also includes Peter Bermel, research scientist in the Research Laboratory for Electronics (RLE); Peter Fisher, professor of physics; and Michael Ghebrebrhan, a postdoc in RLE -- used a slab of tungsten, engineering billions of tiny pits on its surface. When the slab heats up, it generates bright light with an altered emission spectrum because each pit acts as a resonator, capable of giving off radiation at only certain wavelengths.

This powerful approach -- co-developed by John D. Joannopoulos, the Francis Wright Davis Professor of Physics and ISN director, and others -- has been widely used to improve lasers, light-emitting diodes and even optical fibers. The MIT team, supported in part by a seed grant from the MIT Energy Initiative, is now working with collaborators at MIT and elsewhere to use it to create several novel electricity-generating devices.

Mike Waits, an electronics engineer at the Army Research Laboratory in Adelphi, Md., who was not involved in this work, says this approach to producing miniature power supplies could lead to lighter portable electronics, which is "critical for the soldier to lighten his load. It not only reduces his burden, but also reduces the logistics chain" to deliver those devices to the field. "There are a lot of lives at stake," he says, "so if you can make the power sources more efficient, it could be a great benefit."

The button-like device that uses hydrocarbon fuels such as butane or propane as its heat source -- known as a micro-TPV power generator -- has at its heart a "micro-reactor" designed by Klavs Jensen, the Warren K. Lewis Professor of Chemical Engineering, and fabricated in the Microsystems Technology Laboratories. While the device achieves a fuel-to-electricity conversion efficiency three times greater than that of a lithium-ion battery of the same size and weight, Celanovic is confident that with further work his team can triple the current energy density. "At that point, our TPV generator could power your smartphone for a whole week without being recharged," he says.

Celanovic and Soljačić stress that building practical systems requires integrating many technologies and fields of expertise. "It's a really multidisciplinary effort," Celanovic says. "And it's a neat example of how fundamental research in materials can result in new performance that enables a whole spectrum of applications for efficient energy conversion."

Note: The full version of the MITEI story is available at: http://web.mit.edu/mitei/research/spotlights/making-electricity-with-photovoltaics.html

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Massachusetts Institute of Technology. The original article was written by Nancy W. Stauffer, MITEI. David L. Chandler contributed to the story.

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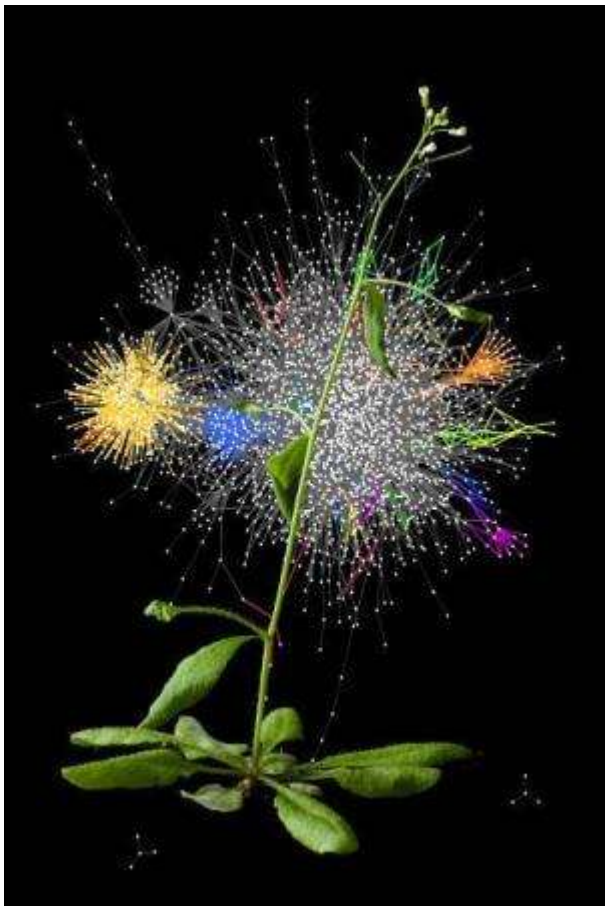
Largest-Ever Map of Plant Protein Interactions



The image shows an Arabidopsis plant overlaid on a network map of protein-protein interactions. The clusters of colors represent "communities" of interacting proteins that are enriched in specific plant processes. (Credit: Image courtesy of Joseph R. Ecker, Salk Institute for Biological Studies / Plant Photo: Joe Belcovson, Salk Institute for Biological Studies / Network map: Mary Galli, Salk Institute for Biological Studies and Matija Dreze, Center for Cancer Systems Biology at the Dana-Farber Cancer Institute)

ScienceDaily (July 30, 2011) — An international team of scientists has described their mapping and early analyses of thousands of protein-to-protein interactions within the cells of *Arabidopsis thaliana* -- a variety of mustard plant that is to plant biology what the lab mouse is to human biology.

"With this one study we managed to double the plant protein-interaction data that are available to scientists," says Salk Institute plant biologist Joseph Ecker, a professor in the Plant Molecular and Cellular Biology Laboratory. "These data along with data from future 'interactome' mapping studies like this one should enable biologists to make agricultural plants more resistant to drought and diseases, more nutritious, and generally more useful to mankind."

The four-year project was funded by an $8 million National Science Foundation grant, and was headed by Marc Vidal, Pascal Braun, David Hill and colleagues at the Dana Farber Cancer Institute in Boston; and Ecker at the Salk Institute. "It was a natural collaboration," says Vidal, "because Joe and his colleagues at the Salk Institute had already sequenced the *Arabidopsis* genome and had cloned many of the protein-coding genes,

whereas on our side at the Dana Farber Institute we had experience in making these protein interaction maps for other organisms such as yeast."

In the initial stages of the project, members of Ecker's lab led by research technician Mary Galli converted most of their accumulated library of *Arabidopsis* protein-coding gene clones into a form useful for protein-interaction tests. "For this project, over 10,000 'open reading frame' clones were converted and sequence verified in preparation for protein-interaction screening," says Galli.

Vidal, Braun, Hill and their colleagues systematically ran these open reading frames through a high quality protein-interaction screening process, based on a test known as the yeast two-hybrid screen. Out of more than forty million possible pair combinations, they found a total of 6,205 *Arabidopsis* protein- protein interactions, involving 2,774 individual proteins. The researchers confirmed the high quality of these data, for example by showing their overlap with protein interaction datafrom past studies.

The new map of 6,205 protein partnerings represents only about two percent of the full protein- protein "interactome" for *Arabidopsis*, since the screening test covered only a third of all *Arabidopsis* proteins, and wasn't sensitive enough to detect many weaker protein interactions. "There will be larger maps after this one," says Ecker.

Even as a preliminary step, though, the new map is clearly useful. The researchers were able to sort the protein interaction pairs they found into functional groups, revealing networks and "communities" of proteins that work together. "There had been very little information, for example, on how plant hormone signaling pathways communicate with one another," says Ecker. "But in this study we were able to find a number of intriguing links between these pathways."

A further analysis of their map provided new insight into plant evolution. Ecker and colleagues *Arabidopsis* genome data, reported a decade ago, had revealed that plants randomly duplicate their genes to a much greater extent than animals do. These gene duplication events apparently give plants some of the genetic versatility they need to stay adapted to shifting environments. In this study, the researchers found 1900 pairs of their mapped proteins that appeared to be the products of ancient gene-duplication events.

Using advanced genomic dating techniques, the researchers were able to gauge the span of time since each of these gene-duplication events -- the longest span being 700 million years -- and compare it with the changes in the two proteins' interaction partners. "This provides a measure of how evolution has rewired the functions of these proteins," says Vidal. "Our large, high-quality dataset and the naturally high frequency of these gene duplications in *Arabidopsis* allowed us to make such an analysis for the first time."

The researchers found evidence that the *Arabidopsis* protein partnerships tend to change quickly after the duplication event, then more slowly as the duplicated gene settles into its new function and is held there by evolutionary pressure. "Even though the divergence of these proteins' amino-acid sequences may continue, the divergence in terms of their respective partners slows drastically after a rapid initial change, which we hadn't expected to see," Vidal says.

In the July 29 issue of Science researchers from the *Arabidopsis* interactome mapping study reported yet another demonstration of the usefulness of their approach. Led by Jeffery L. Dangl of the University of North Carolina at Chapel Hill, they examined *Arabidopsis* protein interactions with the bacterium Pseudomonas syringae (Psy) and a fungus-like microbe called Hyaloperonospora arabidopsidis (Hpa). "Even though these two pathogens are separated by about a billion years of evolution, it turns out that the 'effector' proteins they use to subvert *Arabidopsis* cells during infection are both targeted against the same set of highly connected *Arabidopsis* proteins," says Ecker. "We looked at some of these targeted *Arabidopsis* proteins and found evidence that they serve as 'hubs' or control points for the plant immune system and related systems."

Ecker and his colleagues hope that these studies mark the start of a period of rapid advancement in understanding plant biology, and in putting that knowledge to use for human benefit. "This starts to give us a big, systems-level picture of how *Arabidopsis* works, and much of that systems-level picture is going to be relevant to -- and guide further research on -- other plant species, including those used in human agriculture and even pharmaceuticals,"Ecker says.

The "*Arabidopsis* Interactome Mapping Consortium" consists of over 20 national and international laboratories that contribute to this study with support from a number of funding agencies including the National Science Foundation and the National Institutes of Health.

Story Source:

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Fall of the Neanderthals: Volume of Modern Humans Infiltrating Europe Cited as Critical Factor

Map of the migration of modern man out of Africa. Triangles represent Aurignacian (considered the first modern humans) split-base points. (Credit: Dora Kemp, McDonald Institute for Archaeological Research)

ScienceDaily (July 29, 2011) — New research sheds light on why, after 300,000 years of domination, European Neanderthals abruptly disappeared. Researchers from the University of Cambridge have discovered that modern humans coming from Africa swarmed the region, arriving with over ten times the population as the Neanderthal inhabitants.

The reasons for the relatively sudden disappearance of the European Neanderthal populations across the continent around 40,000 years ago has for long remained one of the great mysteries of human evolution. After 300 millennia of living, and evidently flourishing, in the cold, sub-glacial environments of central and western Europe, they were rapidly replaced over all areas of the continent by new, anatomically and genetically 'modern' (i.e. Homo sapiens) populations who had originated and evolved in the vastly different tropical environments of Africa.

The most plausible answer to this long-debated question has now been published in the journal *Science* by two researchers from the Department of Archaeology at Cambridge -- Professor Sir Paul Mellars, Professor Emeritus of Prehistory and Human Evolution, and Jennifer French, a second-year PhD student.

By conducting a detailed statistical analysis of the archaeological evidence from the classic 'Perigord' region of southwestern France, which contains the largest concentration of Neanderthal and early modern human sites in Europe, they have found clear evidence that the earliest modern human populations penetrated the region in at least ten times larger numbers than those of the local Neanderthal populations already established in the same regions. This is reflected in a sharp increase in the total number of occupied sites, much higher densities of occupation residues (i.e. stone tools and animal food remains) in the sites, and bigger areas of occupation in the sites, revealing the formation of much larger and apparently more socially integrated social groupings.

Faced with this dramatic increase in the incoming modern human population, the capacity of the local Neanderthal groups to compete for the same range of living sites, the same range of animal food supplies (principally reindeer, horse, bison and red deer), and the same scarce fuel supplies to tide the groups over the extremely harsh glacial winters, would have been massively undermined. Additionally, almost inevitably, repeated conflicts or confrontations between the two populations would arise for occupation of the most attractive locations and richest food supplies, in which the increased numbers and more highly coordinated activities of the modern human groups would ensure their success over the Neanderthal groups.

The archaeological evidence also strongly suggests that the incoming modern groups possessed superior hunting technologies and equipment (e.g. more effective and long-range hunting spears), and probably more efficient procedures for processing and storing food supplies over the prolonged and exceptionally cold glacial winters. They also appear to have had more wide-ranging social contacts with adjacent human groups to allow for trade and exchange of essential food supplies in times of food scarcity.

Whether the incoming modern human groups also possessed more highly developed brains and associated mental capacities than the Neanderthals remains at present a matter of intense debate. But the sudden appearance of a wide range of complex and sophisticated art forms (including cave paintings), the large-scale production of elaborate decorative items (such as perforated stone and ivory beads, and imported sea shells), and clearly 'symbolic' systems of markings on bone and ivory tools -- all entirely lacking among the preceding Neanderthals -- strongly point to more elaborate systems of social communications among the modern groups, probably accompanied by more advanced and complex forms of language.

All of these new and more complex behavioural patterns can be shown to have developed first among the ancestral African *Homo sapiens* populations, at least 20,0000 to 30,000 years before their dispersal from Africa, and progressive colonisation (and replacement of earlier populations) across all regions of Europe and Asia from around 60,000 years onwards.

If, as the latest genetic evidence strongly suggests, the African *Homo sapiens* and European Neanderthal populations had been evolving separately for at least half a million years, then the emergence of some significant contrasts in the mental capacities of the two lineages would not be a particularly surprising development, in evolutionary terms.

Professor Sir Paul Mellars, Professor Emeritus of Prehistory and Human Evolution at the Department of Archaeology, said: "In any event, it was clearly this range of new technological and behavioural innovations which allowed the modern human populations to invade and survive in much larger population numbers than those of the preceding Neanderthals across the whole of the European continent. Faced with this kind of competition, the Neanderthals seem to have retreated initially into more marginal and less attractive regions of the continent and eventually -- within a space of at most a few thousand years -- for their populations to have declined to extinction -- perhaps accelerated further by sudden climatic deterioration across the continent around 40,000 years ago."

Whatever the precise cultural, behavioural and intellectual contrasts between the Neanderthals and intrusive modern human populations, this new study published in *Science* demonstrates for the first time the massive numerical supremacy of the earliest modern human populations in western Europe, compared with those of the preceding Neanderthals, and thereby largely resolves one of the most controversial and long-running debates over the rapid decline and extinction of the enigmatic Neanderthal populations.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Cambridge.

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'Brain Cap' Technology Turns Thought Into Motion; Mind-Machine Interface Could Lead to New Life-Changing Technologies for Millions of People

University of Maryland associate professor of kinesiology Jose "Pepe" Contreras-Vidal wears his Brain Cap, a noninvasive, sensor-lined cap with neural interface software that soon could be used to control computers, robotic prosthetic limbs, motorized wheelchairs and even digital avatars. (Credit: John Consoli, University of Maryland)

ScienceDaily (July 29, 2011) — "Brain cap" technology being developed at the University of Maryland allows users to turn their thoughts into motion. Associate Professor of Kinesiology José 'Pepe' L. Contreras-Vidal and his team have created a non-invasive, sensor-lined cap with neural interface software that soon could be used to control computers, robotic prosthetic limbs, motorized wheelchairs and even digital avatars.

"We are on track to develop, test and make available to the public- within the next few years -- a safe, reliable, noninvasive brain computer interface that can bring life-changing technology to millions of people whose ability to move has been diminished due to paralysis, stroke or other injury or illness," said Contreras-Vidal of the university's School of Public Health.

The potential and rapid progression of the UMD brain cap technology can be seen in a host of recent developments, including a just published study in the *Journal of Neurophysiology*, new grants from the National Science Foundation (NSF) and National Institutes of Health, and a growing list of partners that includes the University of Maryland School of Medicine, the Veterans Affairs Maryland Health Care System, the Johns Hopkins University Applied Physics Laboratory, Rice University and Walter Reed Army Medical Center's Integrated Department of Orthopaedics & Rehabilitation.

"We are doing something that few previously thought was possible," said Contreras-Vidal, who is also an affiliate professor in Maryland's Fischell Department of Bioengineering and the university's Neuroscience and

Cognitive Science Program. "We use EEG [electroencephalography] to non-invasively read brain waves and translate them into movement commands for computers and other devices.

Peer Reviewed

Contreras-Vidal and his team have published three major papers on their technology over the past 18 months, the latest a just released study in the *Journal of Neurophysiology* in which they successfully used EEG brain signals to reconstruct the complex 3-D movements of the ankle, knee and hip joints during human treadmill walking. In two earlier studies they showed (1) similar results for 3-D hand movement and (2) that subjects wearing the brain cap could control a computer cursor with their thoughts.

Alessandro Presacco, a second-year doctoral student in Contreras-Vidal's Neural Engineering and Smart Prosthetics Lab, Contreras-Vidal and co-authors write that their *Journal of Neurophysiology* study indicated "that EEG signals can be used to study the cortical dynamics of walking and to develop brain-machine interfaces aimed at restoring human gait function."

There are other brain computer interface technologies under development, but Contreras-Vidal notes that these competing technologies are either very invasive, requiring electrodes to be implanted directly in the brain, or, if noninvasive, require much more training to use than does UMD's EEG-based, brain cap technology.

Partnering to Help Sufferers of Injury and Stroke

Contreras-Vidal and his team are collaborating on a rapidly growing cadre projects with researchers at other institutions to develop thought-controlled robotic prosthetics that can assist victims of injury and stroke. Their latest partnership is supported by a new $1.2 million NSF grant. Under this grant, Contreras-Vidal's Maryland team is embarking on a four-year project with researchers at Rice University, the University of Michigan and Drexel University to design a prosthetic arm that amputees can control directly with their brains, and which will allow users to feel what their robotic arm touches.

"There's nothing fictional about this," said Rice University co-principal investigator Marcia O'Malley, an associate professor of mechanical engineering. "The investigators on this grant have already demonstrated that much of this is possible. What remains is to bring all of it -- non-invasive neural decoding, direct brain control and [touch] sensory feedback -- together into one device."

In a NIH-supported project underway, Contreras-Vidal and his colleagues are pairing their brain cap's EEG-based technology with a DARPA-funded next-generation robotic arm designed by researchers at the Johns Hopkins Applied Physics Laboratory to function like a normal limb. And the UMD team is developing a new collaboration with the New Zealand's start-up Rexbionics, the developer of a powered lower-limb exoskeleton called Rex that could be used to restore gait after spinal cord injury.

Two of the earliest partnerships formed by Contreras-Vidal and his team are with the University of Maryland School of Medicine in Baltimore and the Veterans Affairs Medical Center in Baltimore. A particular focus of this research is the use of the brain cap technology to help stroke victims whose brain injuries affect their motor-sensory control. Originally funded by a seed grant from the University of Maryland, College Park and the University of Maryland, Baltimore, the work now also is supported by a VA merit grant (anklebot BMI) and an NIH grant (Stroke).

"There is a big push in brain science to understand what exercise does in terms of motor learning or motor retraining of the human brain," says Larry Forrester, an associate professor of physical therapy and rehabilitation science at the University of Maryland School of Medicine.

For the more than a year, Forrester and the UMD team have tracked the neural activity of people on a treadmill doing precise tasks like stepping over dotted lines. The researchers are matching specific brain activity recorded in real time with exact lower-limb movements.

This data could help stroke victims in several ways, Forrester says. One is a prosthetic device, called an "anklebot," or ankle robot, that stores data from a normal human gait and assists partially paralyzed people. People who are less mobile commonly suffer from other health issues such as obesity, diabetes or cardiovascular problems, Forrester says, "so we want to get [stroke survivors] up and moving by whatever means possible."

The second use of the EEG data in stroke victims is more complex, yet offers exciting possibilities. "By decoding the motion of a normal gait," Contreras-Vidal says, "we can then try and teach stroke victims to think in certain ways and match their own EEG signals with the normal signals." This could "retrain" healthy areas of the brain in what is known as neuroplasticity.

One potential method for retraining comes from one of the Maryland research team's newest members, Steve Graff, a first-year bioengineering doctoral student. He envisions a virtual reality game that matches real EEG data with on-screen characters. "It gives us a way to train someone to think the right thoughts to generate movement from digital avatars. If they can do that, then they can generate thoughts to move a device," says Graff, who brings a unique personal perspective to the work. He has congenital muscular dystrophy and uses a motorized wheelchair. The advances he's working on could allow him to use both hands -- to put on a jacket, dial his cell phone or throw a football while operating his chair with his mind.

No Surgery Required

During the past two decades a great deal of progress has been made in the study of direct brain to computer interfaces, most of it through studies using monkeys with electrodes implanted in their brains. However, for use in humans such an invasive approach poses many problems, not the least of which is that most people don't' want holes in their heads and wires attached to their brains. "EEG monitoring of the brain, which has a long, safe history for other applications, has been largely ignored by those working on brain-machine interfaces, because it was thought that the human skull blocked too much of the detailed information on brain activity needed to read thoughts about movement and turn those readings into movement commands for multi-functional high-degree of freedom prosthetics," said Contreras-Vidal. He is among the few who have used EEG, MEG or other sensing technologies to develop non-invasive neural interfaces, and the only one to have demonstrated decoding results comparable to those achieved by researchers using implanted electrodes.

A paper Contreras-Vidal and colleagues published in the *Journal of Neuroscience* in March 2010 showed the feasibility of Maryland's EEG-based technology to infer multidimensional natural movement from noninvasive measurements of brain activity. In their two latest studies, Contreras-Vidal and his team have further advanced the development of their EEG brain interface technology, and provided powerful new evidence that it can yield brain computer interface results as good as or better than those from invasive studies, while also requiring minimal training to use.

In a paper published in April in the *Journal of Neural Engineering*, the Maryland team demonstrated that people wearing the EEG brain cap, could after minimal training control a computer cursor with their thoughts and achieve performance levels comparable to those by subjects using invasive implanted electrode brain computer interface systems. Contreras-Vidal and his co-authors write that this study also shows that compared to studies of other noninvasive brain control interface systems, training time with their system was substantially shorter, requiring only a single 40-minute session.

story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by University of Maryland.

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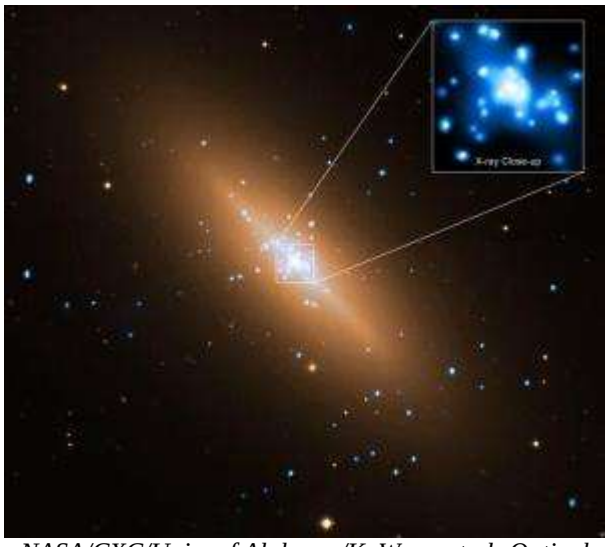
Chandra X-Ray Observatory Images Gas Flowing Toward Black Hole



Composite image of galaxy NGC 3115. (Credit: X-ray: NASA/CXC/Univ. of Alabama/K. Wong et al; Optical: ESO/VLT)

ScienceDaily (July 29, 2011) — The flow of hot gas toward a black hole has been clearly imaged for the first time in X-rays. The observations from NASA's Chandra X-ray Observatory will help tackle two of the most fundamental problems in modern astrophysics: understanding how black holes grow and how matter behaves in their intense gravity.

The black hole is at the center of a large galaxy known as NGC 3115, which is located about 32 million light years from Earth. A large amount of previous data has shown material falling toward and onto black holes, but none with this clear a signature of hot gas.

By imaging the hot gas at different distances from this supermassive black hole, astronomers have observed a critical threshold where the motion of gas first becomes dominated by the black hole's gravity and falls inward. This distance from the black hole is known as the "Bondi radius."

"It's exciting to find such clear evidence for gas in the grip of a massive black hole," said Ka-Wah Wong of the University of Alabama, who led the study that appears in the July 20th issue of *The Astrophysical Journal Letters*. "Chandra's resolving power provides a unique opportunity to understand more about how black holes capture material by studying this nearby object."

As gas flows toward a black hole, it becomes squeezed, making it hotter and brighter, a signature now confirmed by the X-ray observations. The researchers found the rise in gas temperature begins about 700 light years from the black hole, giving the location of the Bondi radius. This suggests the black hole in the center of NGC 3115 has a mass about two billion times that of the sun, making it the closest black hole of that size to Earth.

The Chandra data also show the gas close to the black hole in the center of the galaxy is denser than gas further out, as predicted. Using the observed properties of the gas and theoretical assumptions, the team then estimated that each year gas weighing about 2 percent the mass of the sun is being pulled across the Bondi radius toward the black hole.

Making certain assumptions about how much of the gas's energy changes into radiation, astronomers would expect to find a source that is more than a million times brighter in X-rays than what is seen in NGC 3115.

"A leading mystery in astrophysics is how the area around massive black holes can stay so dim, when there's so much fuel available to light up," said co-author Jimmy Irwin, also of the UA in Tuscaloosa. "This black hole is a poster child for this problem."

There are at least two possible explanations for this discrepancy. The first is that much less material actually falls onto the black hole than flows inside the Bondi radius. Another possibility is that the conversion of energy into radiation is much less efficient than is assumed.

Different models describing the flow of material onto the black hole make different predictions for how quickly the density of the gas is seen to rise as it approaches the black hole. A more precise determination of the rise in density from future observations should help astronomers rule out some of these models.

NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Chandra program for the agency's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory controls Chandra's science and flight operations from Cambridge, Mass.

More information, including images and other multimedia, can be found at: http://chandra.harvard.edu and http://www.nasa.gov/chandra

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by NASA.

Journal Reference:

1. Ka-Wah Wong, Jimmy A. Irwin, Mihoko Yukita, Evan T. Million, William G. Mathews, Joel N. Bregman. Resolving the Bondi Accretion Flow toward the Supermassive Black Hole of NGC 3115 with Chandra. *The Astrophysical Journal*, 2011; 736 (1): L23 DOI: 10.1088/2041-8205/736/1/L23

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Aging Brains Are Different in Humans and Chimpanzees; Evolution of Human Longevity Led to Both a Large Brain and Brain Shrinkage

Research shows chimpanzees, the closest living relatives to humans, do not display significant brain shrinkage as they age. Researchers surmise this may be related to an increased reliance on social learning of skills in humans. (Credit: © Splat-Photo / Fotolia)

ScienceDaily (July 29, 2011) — Brains shrink in humans, potentially causing a number of health problems and mental illnesses as people age, but do they shrink to the same extent in the closest living relatives to humans--the chimpanzees?

New research says no, making the extreme amount of brain shrinkage resulting from normal aging in humans unique.

Chet Sherwood, an anthropologist at The George Washington University in Washington, D.C., and a team of scientists from seven other U.S. universities put forward the question to see if comparable data on the effects of aging could be found in chimpanzees. Such data on regional brain volumes in chimpanzees was not available, until now.

The researchers -- anthropologists, neuroscientists, psychologists, biologists, and veterinary professionals -- used magnetic resonance imaging (MRI) to measure the space occupied by various brain structures in adult humans and chimpanzees, including the frontal lobe and the hippocampus, an area of the brain associated with short-term and long-term memory.

They found chimpanzees do not display significant loss, or atrophy, in the size of their brains and other internal structures as they age.

Instead, Sherwood and colleagues suggest that as humans evolved the ability to live longer, the result was a "high degree of brain degeneration" as people get older.

"We were most surprised that chimpanzees, who are separated from humans by only 6-8 million years of independent evolution, did not more closely resemble the human pattern of brain aging," said Sherwood. "It was already known that macaque monkeys, separated from humans by about 30 million years, do not show humanlike, widespread brain atrophy in aging."

The current issue of *Proceedings of the National Academy of Sciences* reports the findings. The National Science Foundation (NSF) partially funded the research.

Because humans and chimpanzees grow, develop and age on different schedules, the study compared humans from age 22 to 88 and chimpanzees from age 10 to 51. For both species, this encompassed the whole adult lifespan under natural conditions. Humans have a longer lifespan than chimpanzees. In the wild, the lifespan of chimpanzees is about 45 at the oldest. With medical care in captivity, they can live into their 60s. On the other hand, humans without access to modern medical care and who live in traditional hunter-gatherer societies can live to their mid-80s.

The researchers used MRI to measure the volume of the whole brain, total neocortical gray matter, total neocortical white matter, frontal lobe gray matter, frontal lobe white matter and the hippocampus in a cross-sectional sample of 99 chimpanzees and 87 adult humans.

"Traits that distinguish humans from other primates include enlargement of the brain and increased longevity," they write in the report "Aging of the Cerebral Cortex Differs Between Humans and Chimpanzees."

Consequently, they say, humans are unique among animals in being susceptible to certain neuropathologies, such as Alzheimer's disease, in the later stages of life. Even in the absence of disease, however, healthy aging in humans is marked by variable degrees of neural deterioration and cognitive impairment.

"This is an excellent example of research that has implications for societal benefits," said NSF Physical Anthropology Program Officer Kaye Reed. "While Dr. Sherwood and colleagues are interested in the evolutionary significance of brain differences between chimpanzees and humans, the results of this research can be used as a basis to explore degenerative brain diseases, such as Alzheimer's, in a medical context."

"This research points to the uniqueness of how severe brain aging is in humans," said Sherwood. "While there are certainly many similarities between humans and other animals in the degenerative processes that occur in the brain, our research indicates that even healthy, normal aging in humans involves more pronounced brain deterioration than in other species.

"Taken together with particular environmental and genetic risk factors, this might help to explain the fact that only humans are vulnerable to developing dementing illnesses like Alzheimer's disease in old age."

Sherwood and colleagues conclude evolution led to both a large brain and a long lifespan in humans. They point out that the benefits of these traits are much debated, but they surmise it might be related to an increased reliance on social learning of skills.

"As a result, we suggest that the high energy cost of a large brain in humans leads to more wear and tear that cannot be easily repaired because most neurons are not renewed," said Sherwood. "As a consequence, human brains become more vulnerable to degeneration towards the later stages of life."

In addition to NSF, the National Institutes of Health, the James S. McDonnell Foundation, the Mathers Foundation and a Yerkes Center Grant supported the research.

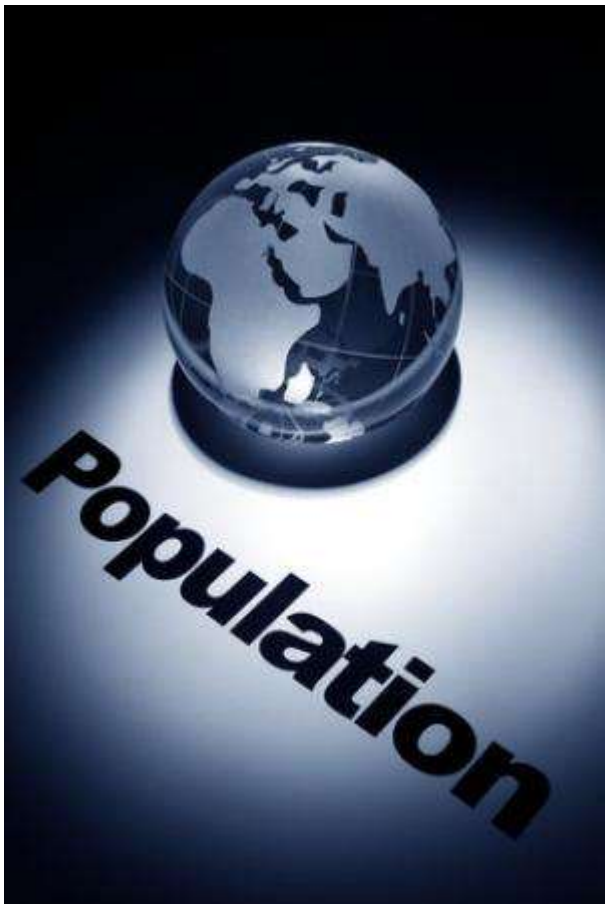
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by National Science Foundation.

Journal Reference:

1. C. C. Sherwood, A. D. Gordon, J. S. Allen, K. A. Phillips, J. M. Erwin, P. R. Hof, W. D. Hopkins. Aging of the cerebral cortex differs between humans and chimpanzees. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1016709108

http://www.sciencedaily.com/releases/2011/07/110727171510.htm

World Population to Surpass 7 Billion in 2011; Explosive Population Growth Means Challenges for Developing Nations



In 2011, global population is expected to hit 7 billion. (Credit: © Feng Yu / Fotolia)

ScienceDaily (July 28, 2011) — Global population is expected to hit 7 billion later this year, up from 6 billion in 1999. Between now and 2050, an estimated 2.3 billion more people will be added -- nearly as many as inhabited the planet as recently as 1950. New estimates from the Population Division of the Department of Economic and Social Affairs of the United Nations also project that the population will reach 10.1 billion in 2100.

These sizable increases represent an unprecedented global demographic upheaval, according to David Bloom, Clarence James Gamble Professor of Economics and Demography at the Harvard School of Public Health, in a review article published July 29, 2011 in *Science*.

Over the next forty years, nearly all (97%) of the 2.3 billion projected increase will be in the less developed regions, with nearly half (49%) in Africa. By contrast, the populations of more developed countries will remain flat, but will age, with fewer working-age adults to support retirees living on social pensions.

"Although the issues immediately confronting developing countries are different from those facing the rich countries, in a globalized world demographic challenges anywhere are demographic challenges everywhere," said Bloom.

The world's population has grown slowly for most of human history. It took until 1800 for the population to hit 1 billion. However, in the past half-century, population jumped from 3 to 7 billion. In 2011, approximately 135 million people will be born and 57 million will die, a net increase of 78 million people.

Considerable uncertainty about these projections remains, Bloom writes. Depending on whether the number of births per woman continues to decline, the ranges for 2050 vary from 8.1 to 10.6 billion, and the 2100 projections vary from 6.2 to 15.8 billion.

Population trends indicate a shift in the "demographic center of gravity" from more to less developed regions, Bloom writes. Already strained, many developing countries will likely face tremendous difficulties in supplying food, water, housing, and energy to their growing populations, with repercussions for health, security, and economic growth.

"The demographic picture is indeed complex, and poses some formidable challenges," Bloom said. "Those challenges are not insurmountable, but we cannot deal with them by sticking our heads in the sand. We have to tackle some tough issues ranging from the unmet need for contraception among hundreds of millions of women and the huge knowledge-action gaps we see in the area of child survival, to the reform of retirement policy and the development of global immigration policy. It's just plain irresponsible to sit by idly while humankind experiences full force the perils of demographic change."

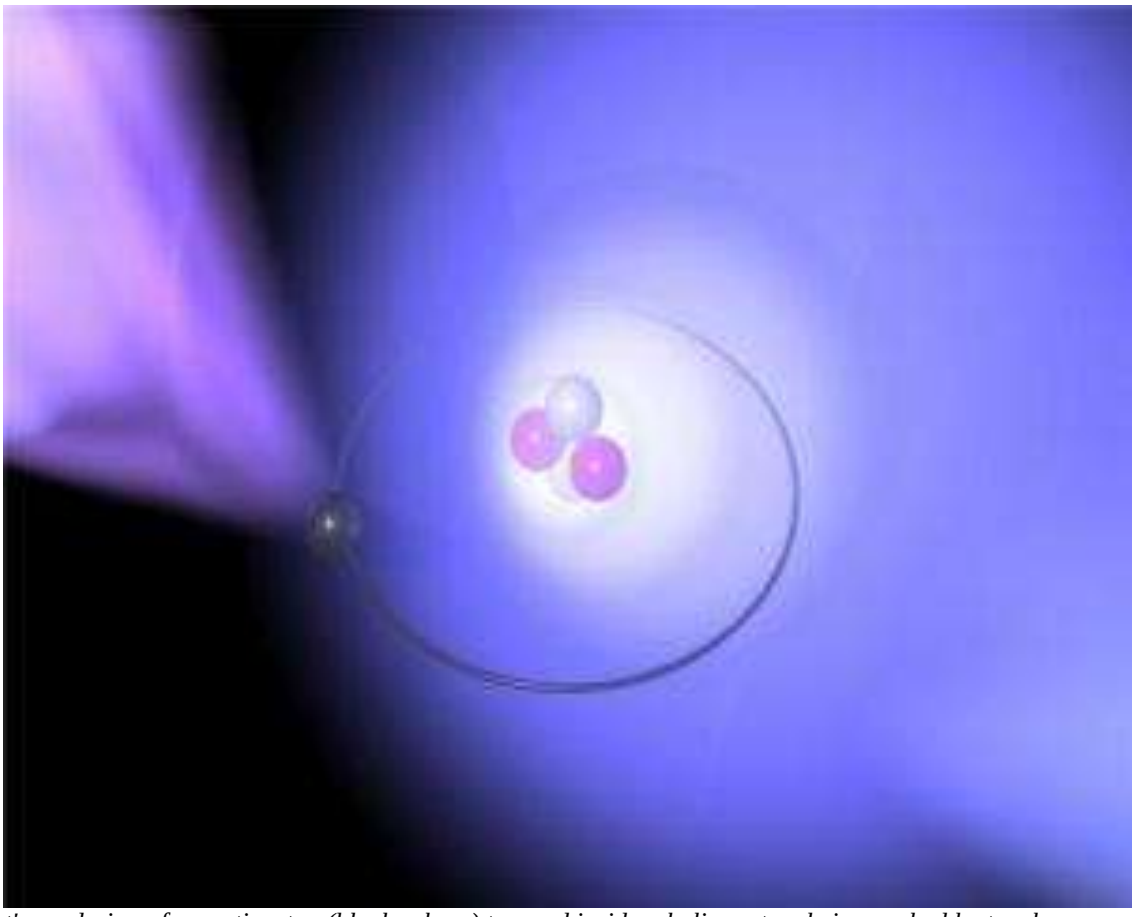
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Harvard School of Public Health.

Journal Reference:

1. David E. Bloom. 7 Billion and Counting. *Science*, 2011; 333 (6042): 562-569 DOI: 10.1126/science.1209290

http://www.sciencedaily.com/releases/2011/07/110728144933.htm

Fundamental Matter-Antimatter Symmetry Confirmed



Artist's rendering of an antiproton (black sphere) trapped inside a helium atom being probed by two laser beams. (Credit: Image courtesy of Max Planck Institute of Quantum Optics)

ScienceDaily (July 28, 2011) — An international collaboration including Max Planck Institute of Quantum Optics scientists has set a new value for the antiproton mass relative to the electron with unprecedented precision.

According to modern cosmology, matter and antimatter were created in equal amounts in the Big Bang at the beginning of the universe. Physicists are developing concepts to explain why the visible universe now seems to be made entirely out of matter. On the other hand, experimental groups are producing antimatter atoms artificially to explore the fundamental symmetries between matter and antimatter, which according to the present theories of particle physics should have exactly the same properties, except for the opposite electrical charge).

Now the independent research group "Antimatter Spectroscopy" of Dr. Masaki Hori, which is associated with the Laser Spectroscopy Division of Prof. Theodor W. Hänsch at the Max Planck Institute of Quantum Optics, has measured the mass of the antiproton relative to the electron with a precision of 1.3 parts per billion (*Nature*, 28 July 2011). For this they used a new method of laser spectroscopy on a half-antimatter, half-matter atom called antiprotonic helium. The result agreed with the proton mass measured to a similar level of precision, confirming the symmetry between matter and antimatter. The experiment was carried out at the European Laboratory for Particle Physics (CERN) in Geneva (Switzerland) in a project led by scientists from

the Max Planck Institute of Quantum Optics and Tokyo University (Japan), and including the University of Brescia (Italy), the Stefan Meyer Institute (Vienna, Austria), and the KFKI Research Institute (Budapest, Hungary).

Physicists believe that the laws of nature obey a fundamental symmetry called "CPT" (this stands for charge conjugation, parity, and time reversal), which postulates that if all the matter in the universe were replaced with antimatter, left and right inverted as if looking into a mirror, and the flow of time reversed, this "anti-world" would be indistinguishable from our real matter world. Antimatter atoms should weigh exactly the same as their matter counterparts. If scientists were to experimentally detect any deviation, however small, it would indicate that this fundamental symmetry is broken. "Small" is the keyword here – it is essential to use the most precise methods and instruments available to make this comparison with the highest possible precision.

Antimatter is extraordinarily difficult to handle in the laboratory, because upon coming into contact with ordinary matter (even the air molecules in a room), it immediately annihilates, converting into energy and new particles. In 1997, researchers from the Max Planck Institute of Quantum Optics in cooperation with other European, Japanese, and American groups began construction of a facility called the Antiproton Decelerator (AD) at CERN. Here antiprotons produced in high-energy collisions are collected and stored in a vacuum pipe arranged in a 190-m-long racetrack shape. The antiprotons are gradually slowed down, before being transported to several experiments. The so-called ASACUSA[1] (Atomic Spectroscopy and Collisions using Slow Antiprotons, named after a district in Tokyo) collaboration, of which Dr. Hori is one of the project leaders, sends the antiprotons into a helium target to create and study antiprotonic helium atoms.

Normal helium atoms consist of a nucleus with two electrons orbiting around it. In antiprotonic helium, one of these electrons is replaced by an antiproton, which finds itself in an excited orbit some 100 picometres (10^{-10} m) from the nucleus. Scientists fire a laser beam onto the atom, and carefully tune its frequency until the antiproton makes a quantum jump from one orbit to another. By comparing this frequency with theoretical calculations, the mass of the antiproton can be determined relative to the electron.

An important source of imprecision arises because the antiprotonic atoms jiggle around randomly according to their thermal energy, so that atoms moving towards the laser beam experience a different frequency compared to those moving away. This is similar to the effect that causes the siren of an approaching ambulance to change pitch as it passes you by. In their previous experiments of 2006, the MPQ / ASACUSA scientists used one laser beam, and this effect limited the precision of their measurement.

This time to go beyond this limit, a technique called "two-photon laser spectroscopy" was used. The atoms were struck by two laser beams travelling in opposite directions, with the result that the effect was partially cancelled, leading to a four to six times higher precision. The first laser caused the antiproton to make a quantum jump to a virtual energy level normally not allowed by quantum mechanics, so that the second laser could actually bring the antiproton up to the closest allowed state. Such a two-photon jump is normally difficult to achieve because the antiproton is heavy, but MPQ scientists accomplished it by building two ultra-sharp lasers and carefully choosing a special combination of laser frequencies. To do this, an optical frequency comb – a special device invented 10 years ago by the group of Prof. Theodor W. Hänsch to measure the frequency of light – was used.

The new measurements showed that the antiproton is 1836.1526736(23) times heavier than the electron, the parenthesis showing the 1-standard deviation imprecision. "We have measured the mass of the antiproton relative to the electron with a precision of 10 digits, and have found it exactly the same as the proton value known with a similar precision", Masaki Hori explains. "This can be regarded as a confirmation of the CPT theorem. Furthermore, we learned that antiprotons obey the same laws of nonlinear quantum optics like normal particles, and we can use lasers to manipulate them. The two-photon technique would allow much

higher precisions to be achieved in the future, so that ultimately the antiproton mass may be better known than the proton one."

The Committee on Data for Science and Technology (CODATA) uses the results of this experiment as one of several input data to determine the proton-to-electron mass ratio, which in turn influences the values of many other fundamental constants. Olivia Meyer-Streng

[1]ASACUSA is one of several experiments studying antimatter at CERN. ATRAP and ALPHA investigate antihydrogen atoms, AeGIS studies how antihydrogen falls under gravity, and ACE studies the possible use of antiprotons for cancer therapy.

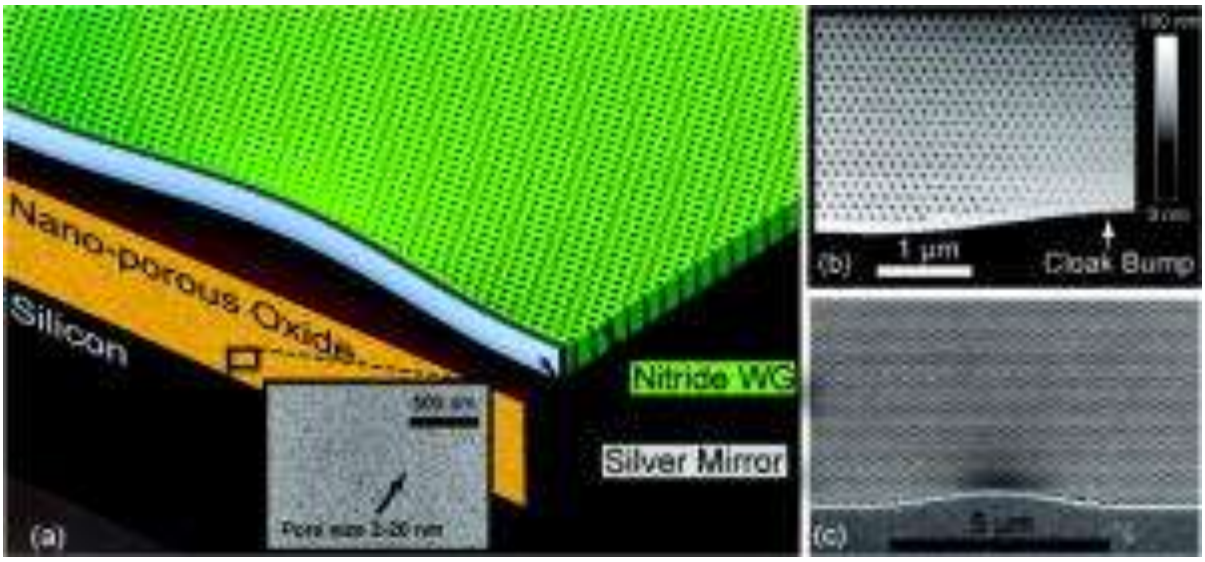
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Max Planck Institute of Quantum Optics, via AlphaGalileo.

Journal Reference:

1. Masaki Hori, Anna Sótér, Daniel Barna, Andreas Dax, Ryugo Hayano, Susanne Friedreich, Bertalan Juhász, Thomas Pask, Eberhard Widmann, Dezső Horváth, Luca Venturelli, Nicola Zurlo. Two-photon laser spectroscopy of antiprotonic helium and the antiproton-to-electron mass ratio. *Nature*, 2011; 475 (7357): 484 DOI: 10.1038/nature10260

http://www.sciencedaily.com/releases/2011/07/110727161135.htm

New Invisibility Cloak Hides Objects from Human View



A real-life invisibility cloak, shown in this cross- sectional illustration, can hide objects from human view. (Credit: ACS)

ScienceDaily (July 28, 2011) — For the first time, scientists have devised an invisibility cloak material that hides objects from detection using light that is visible to humans. The new device is a leap forward in cloaking materials, according to a report in the ACS journal *Nano Letters*.

Xiang Zhang and colleagues note that invisibility cloaks, which route electromagnetic waves around an object to make it undetectable, "are still in their infancy." Most cloaks are made of materials that can only hide things using microwave or infrared waves, which are just below the threshold of human vision. To remedy this, the researchers built a reflective "carpet cloak" out of layers of silicon oxide and silicon nitride etched in a special pattern. The carpet cloak works by concealing an object under the layers, and bending light waves away from the bump that the object makes, so that the cloak appears flat and smooth like a normal mirror.

Although the study cloaked a microscopic object roughly the diameter of a red blood cell, the device demonstrates that it may be "capable of cloaking any object underneath a reflective carpet layer. In contrast to the previous demonstrations that were limited to infrared light, this work makes actual invisibility for the light seen by the human eye possible," the scientists write.

The authors acknowledge funding from the U.S. Army Research Office, the Natural Sciences and Engineering Research Council of Canada, and the NSF Graduate Research Fellowship Program.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by American Chemical Society.

Journal Reference:

1. Majid Gharghi, Christopher Gladden, Thomas Zentgraf, Yongmin Liu, Xiaobo Yin, Jason Valentine, Xiang Zhang. A Carpet Cloak for Visible Light. *Nano Letters*, 2011; 11 (7): 2825 DOI: 10.1021/nl201189z

http://www.sciencedaily.com/releases/2011/07/110727121651.htm

Reservoirs of Ancient Lava Shaped Earth

Geological history has periodically featured giant lava eruptions that coat large swaths of land or ocean floor with basaltic lava, which hardens into rock formations called flood basalt. (Credit: © ollirg / Fotolia)

ScienceDaily (July 28, 2011) — Geological history has periodically featured giant lava eruptions that coat large swaths of land or ocean floor with basaltic lava, which hardens into rock formations called flood basalt. New research from Matthew Jackson and Richard Carlson proposes that the remnants of six of the largest volcanic events of the past 250 million years contain traces of the ancient Earth's primitive mantle -- which existed before the largely differentiated mantle of today -- offering clues to the geochemical history of the planet.

Their work is published online July 27 by *Nature*.

Scientists recently discovered that an area in northern Canada and Greenland composed of flood basalt contains traces of ancient Earth's primitive mantle. Carlson and Jackson's research expanded these findings, in order to determine if other large volcanic rock deposits also derive from primitive sources.

Information about the primitive mantle reservoir -- which came into existence after Earth's core formed but before Earth's outer rocky shell differentiated into crust and depleted mantle -- would teach scientists about the geochemistry of early Earth and how our planet arrived at its present state.

Until recently, scientists believed that Earth's primitive mantle, such as the remnants found in northern Canada and Greenland, originated from a type of meteorite called carbonaceous chondrites. But comparisons of isotopes of the element neodymium between samples from Earth and samples from chondrites didn't produce the expected results, which suggested that modern mantle reservoirs may have evolved from something different.

Carlson, of Carnegie's Department of Terrestrial Magnetism, and Jackson, a former Carnegie fellow now at Boston University, examined the isotopic characteristics of flood basalts to determine whether they were created by a primitive mantle source, even if it wasn't a chondritic one.

They used geochemical techniques based on isotopes of neodymium and lead to compare basalts from the previously discovered 62-million-year-old primitive mantle source in northern Canada's Baffin Island and West Greenland to basalts from the South Pacific's Ontong-Java Plateau, which formed in the largest volcanic event in geologic history. They discovered minor differences in the isotopic compositions of the two basaltic provinces, but not beyond what could be expected in a primitive reservoir.

They compared these findings to basalts from four other large accumulations of lava-formed rocks in Botswana, Russia, India, and the Indian Ocean, and determined that lavas that have interacted with continental crust the least (and are thus less contaminated) have neodymium and lead isotopic compositions similar to an early-formed primitive mantle composition.

The presence of these early-earth signatures in the six flood basalts suggests that a significant fraction of the world's largest volcanic events originate from a modern mantle source that is similar to the primitive reservoir discovered in Baffin Island and West Greenland. This primitive mantle is hotter, due to a higher concentration of radioactive elements, and more easily melted than other mantle reservoirs. As a result, it could be more likely to generate the eruptions that form flood basalts.

Start-up funding for this work was provided by Boston University.

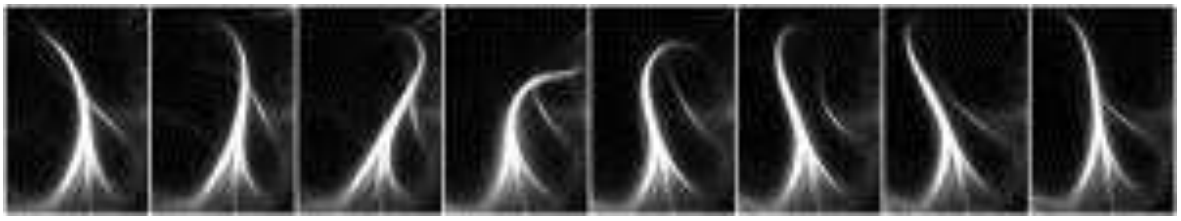
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Carnegie Institution, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Matthew G. Jackson, Richard W. Carlson. An ancient recipe for flood-basalt genesis. *Nature*, 2011; DOI: 10.1038/nature10326

http://www.sciencedaily.com/releases/2011/07/110727131401.htm

Artificial Cilia Open New Nanotech Possibilties; One Step Closer to Learning How Cilia Movement Is Coordinated



Artificial cilia exhibit spontaneous beating. (Credit: Image courtesy of Brandeis University)

ScienceDaily (July 28, 2011) — Cilia -- tiny hair-like structures that perform feats such as clearing microscopic debris from the lungs and determining the correct location of organs during development -- move in mysterious ways. Their beating motions are synchronized to produce metachronal waves, similar in appearance to "the wave" created in large arenas when audience members use their hands to produce a pattern of movement around the entire stadium.

Due to the importance of ciliary functions for health, there is great interest in understanding the mechanism that controls the cilias' beating patterns. But learning exactly how cilia movement is coordinated has been challenging.

That may be beginning to change as a result of the creation, by a team of Brandeis researchers, of artificial cilia-like structures that dramatically offers a new approach for cilia study.

In a recent paper published in the journal *Science*, Associate Professor of Physics Zvonimir Dogic and colleagues present the first example of a simple microscopic system that self-organizes to produce cilia-like beating patterns.

"We've shown that there is a new approach toward studying the beating," says Dogic. "Instead of deconstructing the fully functioning structure, we can start building complexity from the ground up."

The complexity of these structures presents a major challenge as each cilium contains more than 600 different proteins. For this reason, most previous studies of cilia have employed a top-down approach, attempting to study the beating mechanism by deconstructing the fully functioning structures through the systematic elimination of individual components.

The interdisciplinary team consisted of physics graduate student Timothy Sanchez and biochemistry graduate student David Welch who worked with biologist Daniela Nicastro and Dogic. Their experimental system was composed of three main components: microtubule filaments -- tiny hollow cylinders found in both animal and plant cells, motor proteins called kinesin, which consume chemical fuel to move along microtubules and a bundling agent that induces assembly of filaments into bundles.

Sanchez and colleagues found that under a particular set of conditions these very simple components spontaneously organize into active bundles that beat in a periodic manner.

In addition to observing the beating of isolated bundles, the researchers were also able to assemble a dense field of bundles that spontaneously synchronized their beating patterns into traveling waves.

Self-organizing processes of many kinds have recently become a focus of the physics community. These processes range in scale from microscopic cellular functions and swarms of bacteria to macroscopic

phenomena such as flocking of birds and traffic jams. Since controllable experiments with birds, crowds at football stadiums and traffic are virtually impossible to conduct, the experiments described by Sanchez and colleagues could serve as a model for testing a broad range of theoretical predictions.

In addition, the reproduction of such an essential biological functionality in a simple system will be of great interest to the fields of cellular and evolutionary biology, Dogic says. The findings also open a door for the development of one of the major goals of nanotechnology -- to design an object that's capable of swimming independently.

The Dogic lab is currently planning refinements to the system to study these topics in greater depth.

story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by Brandeis University.

Journal Reference:

1. T. Sanchez, D. Welch, D. Nicastro, Z. Dogic. Cilia-Like Beating of Active Microtubule Bundles. *Science*, 2011; 333 (6041): 456 DOI: 10.1126/science.1203963

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