



## News Tip

**December 23, 2003**

### **Climate, Biodiversity and Oldest Humans Mark NSF Science Highlights From 2003**

In 2003, research supported by the National Science Foundation (NSF) continued to make headlines in the United States and around the world. NSF's science success was also recognized in the year's Nobel Prizes – six of the nine Nobel laureates in physics, chemistry, medicine and economics received NSF support during their careers.

Other notable results of NSF support ran the gamut from Ethiopian fossils of newly discovered mammal species and the earliest known *Homo sapiens* to the impact of humans on climate change and biodiversity. These and the other discoveries from 2003 highlighted here demonstrate how NSF continues to promote the progress of science in the 21st century. For more information on these highlights contact the original press officers or David Hart at 703-292-8070 or [dhart@nsf.gov](mailto:dhart@nsf.gov).

## Climate Change—Past, Present and Arctic

After reviewing research by the atmospheric science community, two top scientists reported in the [Dec. 2 issue of the journal \*Science\*](#) that there is no doubt that human activities are having measurable—and increasing—impacts on global climate. For example, the [oceans have experienced large salinity changes in the past 40 years](#), and in Africa, regional climate change has [decreased Lake Tanganyika's fish stocks](#) by as much as 30 percent over the past 80 years. Scientists at the [Study of Environmental Arctic Change \(SEARCH\)](#) meeting in October presented evidence of environmental changes in the Arctic in the hope of formulating multi-agency research strategies to understand those changes. Results from ocean drilling off Africa's coast provided evidence of global warming in Earth's ancient history, pointing to [a release of sea-floor methane](#) and other events as [causes of climate change millions of years ago](#). Another paleoclimate study [linked volcanic eruptions in the tropics to El Niño](#) events.



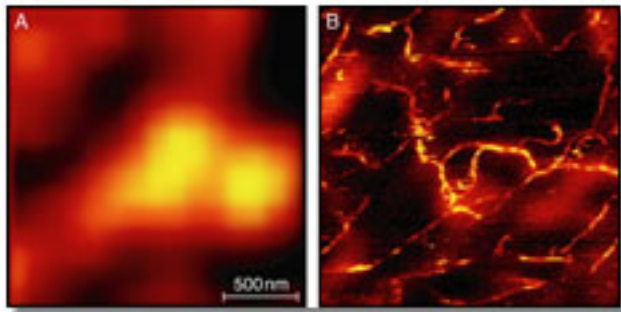
NSF is supporting a five-year, \$3.9 million project, called the [North Pole Environmental Observatory \(NPEO\)](#), placed at a strategic location to study the interplay of ocean currents as well as other factors related to climate change.

*Credit: Peter West / National Science Foundation*

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## New Sights on the Ultra-Small

Researchers reported advances in creating an extreme-ultraviolet (EUV) laser and their hopes of extending the beam's range to a wavelength that will allow unprecedented looks at biological structures. Another team developed a technique that allows scientists to view the short-lived molecules produced during chemical reactions. And a technique for creating the highest-resolution optical images ever revealed structures as small as carbon nanotubes just a few billionths of a meter across.



Images of carbon nanotubes (left) using standard diffraction limited microscopy and (right) using the new technique developed at the University of Rochester.

*Credit: The Institute of Optics, University of Rochester*

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## Ethiopian Fossils Push Back Origins of Modern OF Humans...

A multinational team of scientists uncovered fossils of the earliest modern human (*Homo sapiens*) estimated at 154,000 to 160,000 years old. According to the scientists, the findings provide strong evidence that *Homo sapiens* and Neanderthals co-existed, rather than the former descending from the latter. In two articles appearing in the June 12 *Nature*, the authors describe the fossilized crania of two adults and a child uncovered at the Herto village in the Middle Awash study area of Ethiopia, about 140 miles northeast of its capital, Addis Ababa. The fossils fill a major gap in the human fossil record.



Frontal view of *Homo sapiens idaltu*, BOU-VP-16/1, uncovered at Upper Herto Member, Bouri peninsula, Middle Awash, Ethiopia. The fossil is housed in National Museum of Ethiopia, Addis Ababa.

*Credit: © 2000 David L. Brill \ Brill Atlanta*

## ...And Fill in Evolutionary Past for African Mammals

An international team of researchers reported in the Dec. 4 *Nature* on the discovery of new fossils from the highlands of Ethiopia that fill a long-standing 8-million-year gap in scientists' understanding of the evolution of African mammals. Several of the newly discovered fossils dating from 24 million to 32 million years ago, mark the earliest evidence for some of today's African mammals, while others represent the last holdouts of species thought to be extinct long before. The team was surprised, for example, to find several species of primitive distant cousins of today's elephants—living side by side with more advanced species that are the ancestors of today's elephants. Perhaps the most unusual new fossil and a holdover from much earlier times is the arsinothere, an animal larger than today's rhino with a pair of massive bony horns on its snout.

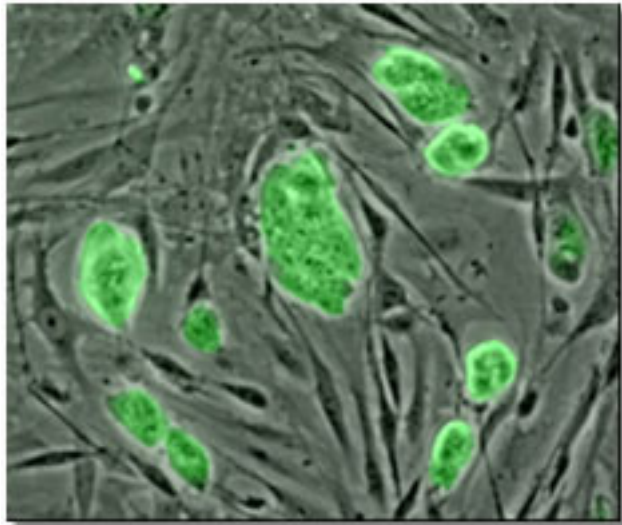


A new species of *Arsinoitherium* found in the Chilga region of Ethiopia is both the largest and the youngest yet discovered.

*Credit: Trent Schindler / National Science Foundation*  
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## Mouse Sperm Engineered from Stem Cells

Starting from embryonic stem cells, researchers using laboratory techniques alone and no animal hosts isolated sex-cell precursors from mouse embryos, coaxed the cells into a sperm-like form, used them to fertilize mouse eggs, and ultimately formed early-stage embryos. Reported in the Dec. 10 *Nature*, the research may potentially help scientists develop treatments for infertility and provide insight into the growth of certain tumors. The study builds upon nearly a decade of research at the Whitehead Institute for Biomedical Research, Harvard University, and the NSF Biotechnology Process Engineering Center (BPEC) at the Massachusetts Institute of Technology (MIT), all in Cambridge, Mass., and most recently at Children's Hospital Boston, the Dana Farber Cancer Institute and Massachusetts General Hospital.



Mouse embryonic stem cells stained with a fluorescent green marker for embryonic germ cells (precursor sex cells).

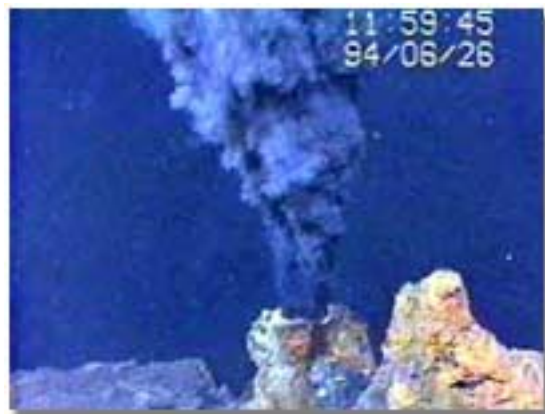
*Credit: Niels Geijsen, Massachusetts General Hospital/National Science Foundation*

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## Hot, Hot, Hot: Microbe Raises the Temperature Limit for Life

It may be small, its habitat harsh, but a newly discovered single-celled microbe leads the hottest existence known to science. The extremophile's discoverers, reporting in the Aug. 15 *Science*, preliminarily named the roughly micron-wide speck "Strain 121" for the top temperature at which it survives: 121 degrees Celsius, or about 250 degrees Fahrenheit. Previously, the upper known temperature limit for life had been 113 C (235 F), a record held by



A "black smoker" vents atop a 10-meter-high chimney, with an internal temperature of 342° C. This vent is about 250 miles south of the vent that yielded the Strain 121 sample.

*Courtesy of Pacific Marine Environmental Laboratory, NOAA.*

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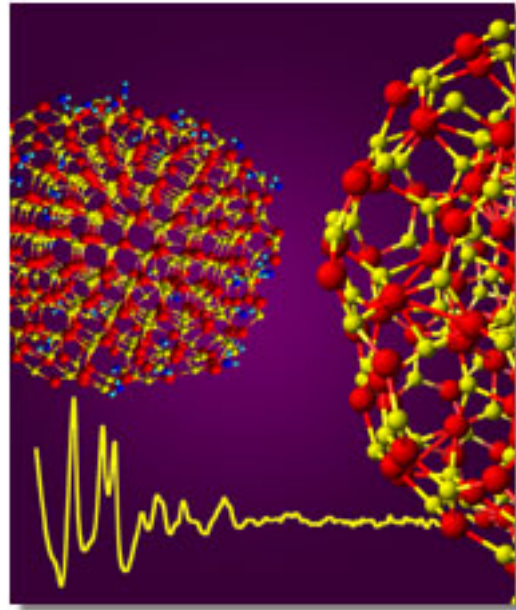
another microbe called *Pyrolobus fumarii*. Strain 121, which uses iron the way humans use oxygen to burn food for energy, comes from the deep-sea realm of hydrothermal vents, where water spouts from leaks in the ocean floor, sometimes at temperatures near 400 C (750 F).

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## Construction at the Nanoscale

As scientists shrink materials down to the nanometer scale, they've found new behaviors that promise unforeseen applications and new ways to get nanoscale components to self-assemble into larger pieces. Studies showed that nanoparticles of silicon can be even harder than sapphire and that nanoparticles change crystal structure when they get wet.

Researchers also developed silica nanowires that guide light with wavelengths wider than the wires, but found that laboratory-standard single-molecule wires between gold contacts have an unavoidable tendency to "blink" randomly. Researchers described tree-like molecules that assemble themselves into precisely structured building blocks of one-quarter of a million atoms and a new designer material assembled from a mixture of magnetic and semiconductor nanoparticles. Another study described a "directed" self-assembly technique that could one day allow electronic devices to assemble themselves automatically.



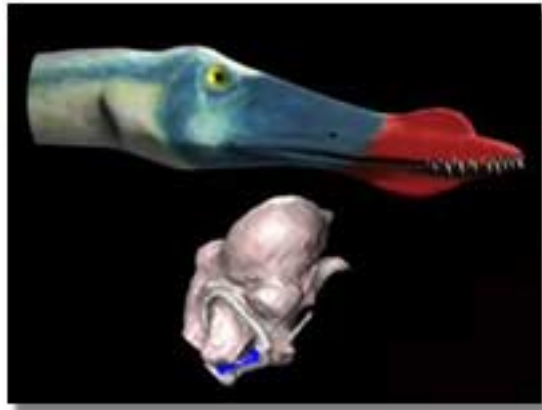
Molecular simulations predict a change from a more distorted to a more periodic structure accompanying binding of water molecules to a nanoparticle surface.

*Credit: H. Zhang, B. Gilbert, F. Huang, J. Banfield, University of California, Berkeley.*

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## Dino-Cannibals and the First in Flight

In a report in the April 3 *Nature*, researchers document the first clear-cut evidence for cannibalism among dinosaurs. Distinct tooth marks on the bones of *Majungatholus atopus*, a 30-foot-long, meat-eating dinosaur from Madagascar, indicate that *Majungatholus* regularly dined upon members of its own species as well as the remains of other dinosaurs. Research reported in the Oct. 30 *Nature* suggests that a specialized brain and inner ear structure helped pterosaurs to fly and target their prey, a finding that could give scientists insight into the evolution of the brain and visual system. And a study of baby birds in the Jan. 17 *Science* offered a new explanation for how reptiles evolved into flying birds. The transition from ground travel to flight may have required a "ramp-up" phase in which rapid movement of the animal's front appendages allowed its body to gain more foot traction as it made its way up increasingly steep slopes.



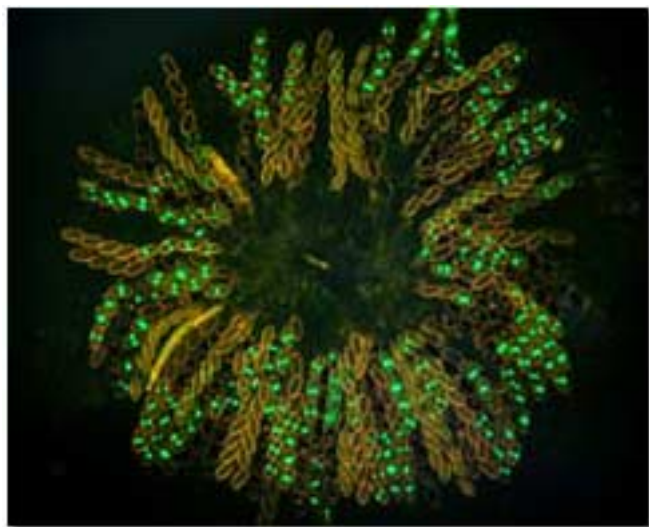
This animation demonstrates the relationship of head orientation to the inclination of the lateral semicircular canals (shown in blue) of the pterosaur *Anhanguera santanae*. When the semicircular canals are brought to a normal near-horizontal position, the long axis of the head turns downward.

*Credit: Trent Schindler / National Science Foundation*

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## Decoding the Genomic Mysteries of Plants

NSF-supported researchers continued to make progress in decoding the genetic blueprints of important plants and other organisms. In 2003, sequenced genomes were announced for the first filamentous fungi (a bread mold), rice chromosome 10, a model microbe for studying plant diseases and four key species of phytoplankton. In addition, researchers identified the first "jumping



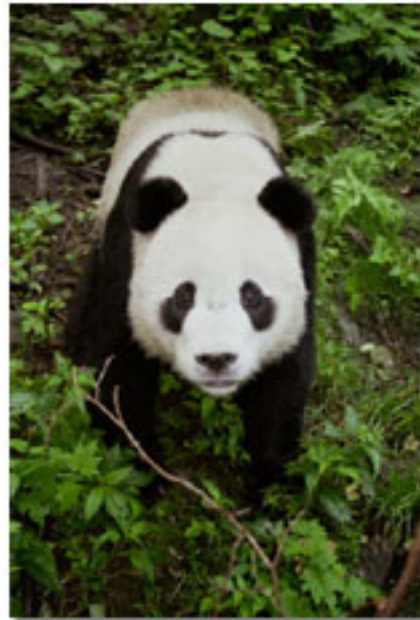
NSF supported the effort to sequence the genome of *Neurospora crassa*, better known as common bread mold, which has served as a powerful laboratory model to study genetics and biological mechanisms for over 60 years.

[genes](#)" in rice, [zeroed in on gene-rich areas of the maize genome](#), released a "knockout map" for the model plant *Arabidopsis* and the first "gene expression" map for 22,000 of the genes in *Arabidopsis*. NSF expanded its support for genomic studies of the plant kingdom, announcing [\\$100 million in new awards](#) from its Plant Genome Program.

*Courtesy of N. B. Raju, Stanford University*  
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## Biodiversity Origins and Human Impacts

Clues to biodiversity's origins were revealed in an ["artificial life" simulation](#) that showed complex functions arising from mutation and natural selection and in a lab experiment with microorganisms that showed how [historical events can affect biodiversity](#). At the same time, increasing numbers of human households are putting [dramatic pressure on ecosystems and their biodiversity](#), according to a study in the Jan. 12 *Nature*. Other studies showed that human land-use practices can have unexpected consequences, such as [increasing the prevalence of Lyme disease](#) or [upsetting forest stability](#) in ways that remain poorly understood. Researchers also showed that ["upscale" neighborhoods show greater biodiversity](#) than less affluent areas.



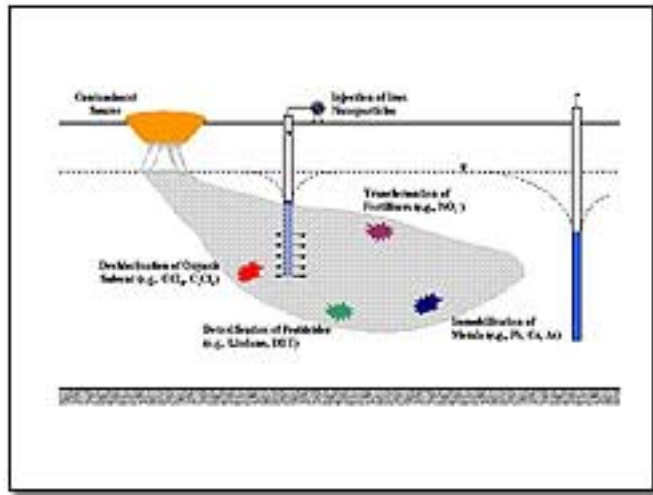
Pandas are rare in the wild, with likely fewer than 1,000 living in shrinking and fragmented habitats of China. U.S. and Chinese researchers are working to better understand habitat challenges and the impact of human interaction on areas of biodiversity such as China's Wolong Nature Reserve.

*Photo Credit: Sue Nichols, Michigan State University*

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## Iron Nano-Powder Cleans Soil and Groundwater

An ultrafine "nanoscale" powder made from iron, one of the most abundant metals on Earth, has turned out to be a remarkably effective tool for cleaning up contaminated soil and groundwater—a trillion-dollar problem that encompasses more than 1,000 still-untreated Superfund sites in the United States, some 150,000 underground storage tank releases, and a large number of landfills, abandoned mines and industrial sites. Reported in the Sept. 3 *Journal of Nanoparticle Research*, iron's cleansing power stems from the simple fact that it rusts, or oxidizes. When metallic iron oxidizes in the presence of contaminants such as trichloroethene, carbon tetrachloride, dioxins or PCBs, these organic molecules get caught up in the reactions and broken down into simple carbon compounds that are far less toxic.



Site remediation with iron nanoparticles.

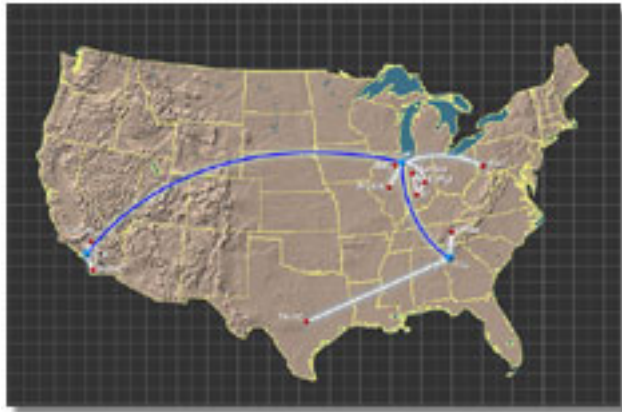
*Credit: Lehigh University*

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## The Expanding Cyberinfrastructure

The Mosaic Web browser, which kicked off the Web revolution of the 1990s, celebrated its 10<sup>th</sup> anniversary in 2003, and NSF continued to advance the state of the nation's computing, information and communications infrastructure. This so-called cyberinfrastructure will "radically empower" scientific and engineering research and allied education, according to the NSF report released in February. NSF cyberinfrastructure-related projects marked successes including helping battle the Coyote wildfire, assisting astronomers in a hunt for supernovas, issuing the third release of middleware components for grid and collaborative computing and deploying the third and fourth most powerful computers in the world.



With awards made in September, NSF's Extensible Terascale Facility now encompasses data, computing and instrumentation resources at 10 sites connected by networks operating at 10 gigabits-per-second or greater through network hubs in Los Angeles, Chicago, and soon Atlanta.

*Credit: NSF*

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## New Catalyst Paves Way for Cheap, Renewable Hydrogen

Scientists have developed a hydrogen-making catalyst that uses cheaper materials and yields fewer contaminants than do current processes, while extracting the element from common renewable plant sources. Further, the new catalyst lies at the heart of a chemical process the authors say is a significant advance in producing alternate fuels from domestic sources. In the June 27 *Science*, researchers reported developing the catalyst from nickel, tin and aluminum and using it in a process that converts plant byproducts to hydrogen. The process performs as well as current methods that use precious metals such as platinum, yet runs at lower temperatures and is much cleaner.

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