RESEARCH HIGHLIGHTS

The shadow of drought

Geophys. Res. Lett. **34,** L15702 (2007)

The worldwide cloud of aerosols produced by the eruption of Mount Pinatubo in 1991 (pictured) led to a remarkable slowing of Earth's hydrological cycle, according to researchers at the National Center for Atmospheric Research in Boulder, Colorado.

Kevin Trenberth and Aiguo Dai show that 1992 was deficient in both precipitation over land and streamflow to a degree unseen in 55 years of records, probably as a result of reduced incoming solar radiation leading to reduced evaporation. The effect remained significant even when the impact of a near-concurrent El Niño event was factored out.

The authors warn that 'geoengineering' projects designed to offset greenhouse warming by reduing the amount of incoming solar radiation on a global scale may have similar consequences.

D. HARLOW/US GEOLOGICAL SURVEY/TIME LIFE PICTURES/GETTY

CELL BIOLOGY

Little helper

Science **317,** 957–961 and 961–964 (2007)

Two studies offer molecular insight into how proteins get into and across cellular membranes.

Both studies suggest that protein structures known as POTRA domains, found in the outer membranes of Gram-negative bacteria, mitochondria and chloroplasts, begin the job by binding membrane-destined proteins.

Vincent Villeret at the Institute of Biology of Lille, France, Françoise Jacob-Dubuisson at the Lille Pasteur Institute and their co-workers solved the structure of part of a membrane protein known as FhaC from *Bordatella pertusis*, which causes whooping cough. FhaC forms a channel that transports virulence proteins across the membrane, opening when a portion of one of its POTRA domains binds the virulence protein.

Daniel Kahne at Harvard University in Cambridge, Massachusetts, and his colleagues studied a fragment of a protein known as YaeT from *Escherichia coli*. It forms a scaffold for a complex that folds other membrane proteins. A portion of one of its POTRA domains seems to bind these proteins.

CHEMISTRY

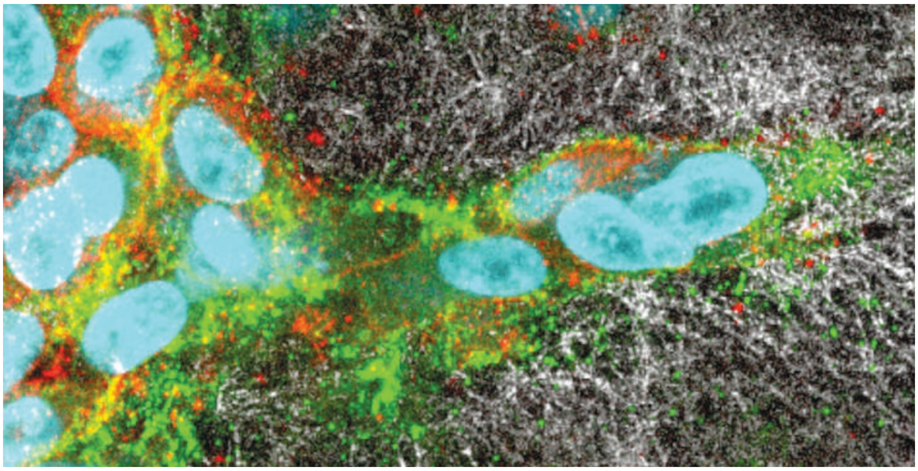
Blinking hot

J. Am. Chem. Soc. doi:10.1021/ja0715905 (2007)

You can't use a medicine-cabinet thermometer in a microlitre of fluid. Scientists wanting to take the temperature of reagents in microfluidic devices might turn to a 'blinking' molecule instead.

The proposal comes from Cécile Fradin and her team at McMaster University in Hamilton, Canada. They note that under laser illumination, enhanced green fluorescent protein switches between a glowing and a dull state with the removal and addition of a proton. How fast the protein 'blinks' depends on two properties of the solution to which it is added: acidity and temperature.

Previous methods to gauge temperature with dyes have relied on changes in fluorescence intensity, which yield only relative measurements. This protein, at known pH, gives an absolute temperature measurement.



CANCER BIOLOGY

Tube travel

Nature Cell Biol. **9,** 893–904 (2007)

With the help of time-lapse microscopy, researchers have revealed how tumours degrade and invade the protein matrix around healthy cells to spread through the body.

Peter Friedl at the University of Würzburg in Germany and his colleagues studied fibrosarcoma and breast cancer cells as the cells invaded three-dimensional blocks of collagen in a lab dish. The team identified two key steps. First, single cells rearrange collagen fibres that are blocking their way into tube-like holes. Then, groups of cells behind the leading cells expand the tubes (pictured left), clearing away larger areas of the matrix with the help of enzymes including membrane-type-1 matrix metalloproteinase (MT1-MMP).

SOLID-STATE PHYSICS

All for one

Nano Lett. **7,** 2506–2512 (2007)

In today's silicon solar cells, which account for more than 90% of the solar-cell market, each absorbed photon produces a pair of charge carriers of fixed energy. Any surplus energy from the original photon is lost as heat.

However, in nanoparticles of certain semiconductors, such as lead selenide, a single photon that has enough energy to produce two or more pairs of charge carriers can do so. Now Matt Beard, Randy Ellingson, Arthur Nozik and other colleagues at the National Renewable Energy Laboratory in Golden, Colorado, show that the same can happen in silicon nanoparticles. This 'multiple exciton generation' would give silicon-nanoparticle-based cells a theoretical peak efficiency of about 44%, compared with around 33% for traditional silicon solar cells. But the researchers have yet to work out how to make use of the charge carriers in such particles.

GENETICS

Red or white

PloS Genet. **3,** e133 (2007)

Researchers have surveyed the genomes of 440 rice strains to work out the evolutionary history of how wild rice lost its red colour to cultivation.

Susan McCouch at Cornell University in Ithaca, New York, and her colleagues report that more than 97% of the white-grained rices they studied have the 14 base-pair deletion previously identified with the loss of the red outer layer, or pericarp, of wild rice grains. Other clues in the genome suggest this mutation arose once in *japonica* subspecies and then spread around the world, probably through human trade. It is thought that humans might have preferred white rice over red for its novelty, its softer shell, or because it was easier to pick out insects or dirt from a meal. A second mutation associated with white grains appeared in fewer than 3% of species studied.

ECOLOGY

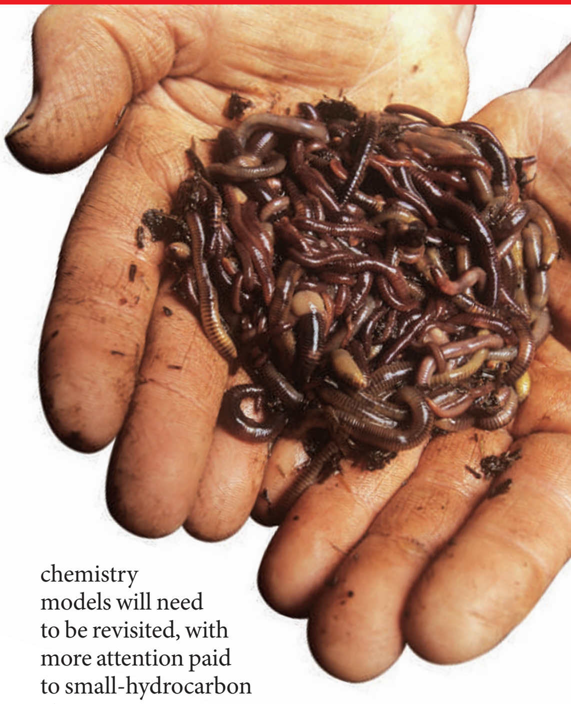
Worm wood

Conserv. Biol. **21,** 997–1008 (2007)

Traipsing through the sugar-maple forests of North America has become a different experience since alien earthworms invaded.

Andrew Holdsworth and his team at the University of Minnesota in St Paul have examined various sites in two National Forests in the northern United States. They found a clear negative correlation between the presence of worms from the European genus *Lumbricus* (pictured right) and plant diversity, particularly the diversity of small non-grassy plants, or forbs.

This confirms past observations of *Lumbricus* disrupting native plant assemblages. The suggested reason? The European worms eat leaf litter that would otherwise shelter seeds and host nutrient-providing fungi. As a result, species such as wild sarsaparilla (*Aralia nudicaulis* L.) and rose twisted stalk (*Streptopus roseus* Michx.) disappear.



S. STAMMERS/SPL

ASTRONOMY

Chemical misfit

Astrophys. J. **665,** L127–L130 (2007)

Propene has been detected in space for the first time, in a dark interstellar cloud in the constellation of Taurus. No one had previously looked for the molecule (C_3H_6) because, although such clouds can be rich in hydrocarbons, there seemed to be no obvious mechanism by which propene would form.

Núria Marcelino at Instituto de Estructura de la Materia in Madrid, Spain, and her colleagues made the discovery with the IRAM 30-metre radio telescope near Granada. Marcalino's team suggests that now they have found propene, interstellar chemistry models will need to be revisited, with more attention paid to small-hydrocarbon chemistry.

QUANTUM PHYSICS

Massive interference

Nature Phys. doi:10.1038/nphys701 (2007)

Shooting a beam of electrons, atoms or molecules through a grating is the classic way to reveal the particles' quantum wave-like nature. The beam produces an interference pattern, just as light would.

Markus Arndt of the University of Vienna, Austria, and his colleagues report a nifty way to extend this technique to larger molecules than it has been possible to study so far.

Large molecules tend to interact with a grating, blurring the interference pattern. Arndt's team overcome this problem with a clever arrangement of three gratings — the second made not of material, but of a 'standing wave' of light. The properties of the light barrier can be tuned to optimize the contrast of the interference image, as the authors demonstrate for ^{70}C — a fullerene — and azobenzene molecules.

JOURNAL CLUB

David Stevenson
California Institute of Technology, USA

A planetary scientist foresees a shift in the debate about Earth's heat flow.

Measurements of the heat coming out of Earth's interior have long posed a puzzle for understanding the planet's history.

Earth's heat output is estimated to be around 44 terawatts, about twice that expected from radioactive decay. The difference can be attributed to cooling of the deep Earth, implying a present-day cooling rate of 100 kelvin per billion years. But simple models with this much cooling 'blow up' when they are run back in time, predicting ridiculous temperatures for the early Earth. Acceptable models rely on unconventional deviations from the usual simple scaling laws for mantle convection. This is an attractive but untested idea.

I and many others have wondered whether an alternative explanation is that today's heat flow is higher than the average for the past half a billion years. Such fluctuations could arise as a result of the dispersal and accumulation of continental land masses.

A recent paper (J. Korenaga *Earth Planet. Sci. Lett.* **257,** 350–358; 2007) assessed this possibility by taking advantage of a long-known connection between sea level and the heat flow from sea-floor spreading. It finds little room for more than a few percent fluctuation in heat flow around its long-term decline.

I think this pushes the problem back into the realm of models, focusing attention on plate tectonics, the deep water cycle (because water affects how rocks flow), and perhaps even the long-standing question of whether Earth's mantle is well mixed from top to bottom.

On a decadal timescale, we can hope that better measurements of heat generation and flow will be combined with more realistic theory. Like many central Earth science questions, the heat-flow problem resists quick resolution.

Discuss this paper at **http://blogs.nature.com/nature/journalclub**