



IN SCIENCE JOURNALS

Edited by Stella Hurtley

The Colorado potato beetle
(*Leptinotarsa decemlineata*)



PEST CONTROL

Bypassing a plant's defense for pest defense

Colorado potato beetles can skeletonize the leaves on a potato plant, devastating crop yields. Insecticides are increasingly useless as the beetle evolves resistance. Zhang *et al.* used RNA interference to take down this beetle (see the Perspective by Whyard). Success required shifting production of the double-stranded RNA to the plastids to evade the plant's own RNA management mechanisms. The insect's own RNA interference mechanisms then inactivated two everyday genes that the beetle can't do without. — PJH

Science, this issue p. 991; see also p. 950

MOSQUITO BIOLOGY

Mating plugs promote malaria parasites

Males of some of the malaria-transmitting mosquitoes "plug" females after copulation to stop interloping males from mating. The mating plug also delivers a steroid hormone into the female uterus. This hormone pulse promotes egg production and stimulates egg laying. It also curbs the mosquitoes' immune responses, which allows parasites such as malaria to develop unhindered. Mitchell *et al.* discovered that plugs are a recent evolutionary acquisition (see the Perspective by Alonzo). South American anopheline mosquitoes lack these plugs altogether, whereas African and Indian species have complex plugs replete with hormones. It is unlikely to be a coincidence that the most elaborate mosquito plugs are

also found in regions where malaria transmission rates are highest. — CA

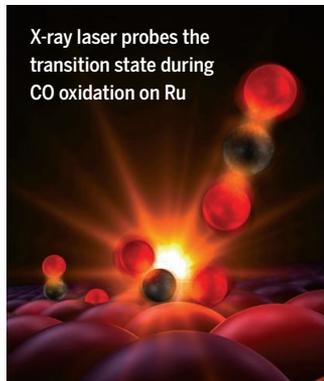
Science, this issue p. 985;
see also p. 948

SURFACE CHEMISTRY

Catching CO oxidation

Details of the transition state that forms as carbon monoxide (CO) adsorbed on a ruthenium surface

X-ray laser probes the transition state during CO oxidation on Ru



is oxidized to CO₂ have been revealed by ultrafast excitation and probe methods. Öström *et al.* initiated the reaction between CO and adsorbed oxygen atoms with laser pulses that rapidly heated the surface and then probed the changes in electronic structure with oxygen x-ray absorption spectroscopy. They observed transition-state configurations that are consistent with density functional theory and a quantum oscillator model. — PDS

Science, this issue p. 978

OPTICS

Light with twist and structure

Möbius strips are three-dimensional structures consisting of a surface with just a single side. Readily demonstrated by snipping a paper ring, adding a twist, and then joining the ends

of paper together again, these structures have intriguing mathematical properties in terms of topology and geometry. Bauer *et al.* used a liquid crystal to engineer the wavefront of a laser beam to make an optical version of the Möbius strip by effectively "snipping and twisting" the polarization properties of the light beam. — ISO

Science, this issue p. 964

CLIMATE CHANGE

Is the end of the warming hiatus nigh?

Which recent climate changes have been forced by greenhouse gas emissions, and which have been natural fluctuations of the climate system? Steinman *et al.* combined observational data and a large collection of climate models to assess the Northern Hemisphere climate over the past

150 years (see the Perspective by Booth). At various points in time, the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation have played particularly large roles in producing temperature trends. Their effects have combined to cause the apparent pause in warming at the beginning of the 21st century, known as the warming “hiatus.” This pause is projected to end in the near future as temperatures resume their upward climb.

— HJS

Science, this issue p. 988;
see also p. 952

ARCHAEOLOGY

Early wheat movement into Britain

The transition into the New Stone Age, or Neolithic period, in Great Britain and Europe was characterized by a change from hunter-gatherers to farmers. However, the early stages of this transition are not well understood. Smith *et al.* studied archaeological remains at an 8000-year-old site that has been underwater ever since the Neolithic (see the Perspective by Larson). The finds include evidence of wheat (or a relative of wheat) 2000 years before the first documented farmers in Britain. It seems that trade may have preceded the adoption of farming. — LMZ

Science, this issue p. 998;
see also p. 945

LUNG DISEASE

Mucus: It's the quality that counts

In patients with cystic fibrosis (CF) or other lung diseases, airway mucus can be highly elastic and very difficult to clear, leading to airflow obstruction and lung infection. Now, Yuan *et al.* show that the biophysical properties of mucus from CF patients are altered because of neutrophilic oxidative stress. To combat this, they targeted mucin disulfide crosslinks with a thiol-modified carbohydrate and produced fast-acting mucolytic activity toward CF sputum. Their findings

support the use of mucolytics as a therapeutic strategy for treating CF and related inflammatory lung diseases. — ACC

Sci. Transl. Med. **7**, 276ra27 (2015).

FUEL CELLS

Metal-free catalysts for fuel cell technology

Metal-free catalysts have recently been designed for use in alkaline fuel cells. Dai *et al.* have successfully used a metal-free catalyst in an acidic polymer electrolyte membrane fuel cell: the mainstream fuel cell technology. Nitrogen-doped carbon nanotubes and their graphene composites catalyzed oxygen reduction in these practical fuel cells. The carbon-based catalysts showed both excellent activity and durability and offer an inexpensive alternative to metal-based catalysts. Such an approach could potentially reduce the manufacturing cost of fuel cells dramatically and open the door for their commercialization. — ZHK

Sci. Adv. 10.1126/
sciadv.1400129 (2015).

EBOLA VIRUS

Channeling Ebola virus entry into the cell

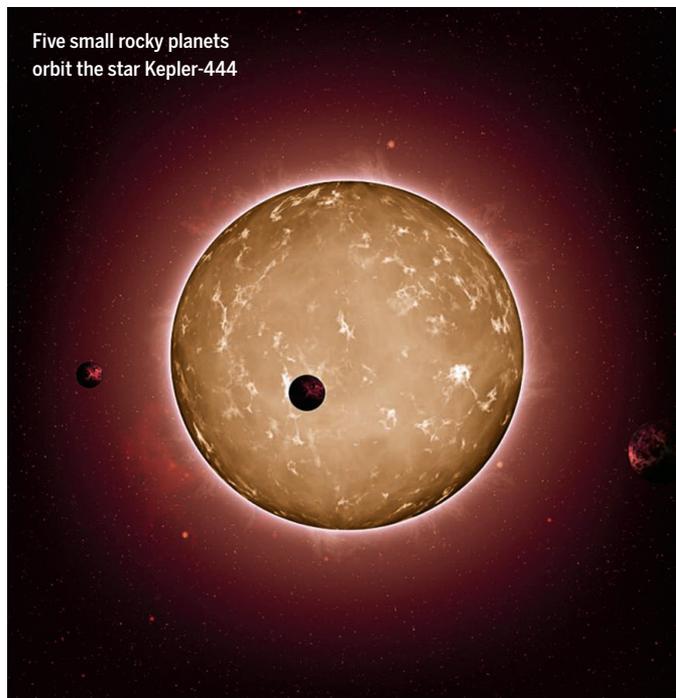
The current outbreak of Ebola virus in West Africa highlights the need for antiviral therapies. One strategy would be to block the Ebola virus's ability to enter host cells. Cells engulf Ebola virus particles, which then traffic into the cell in structures called endosomes. Sakurai *et al.* now report that the Ebola virus requires calcium channels called two-pore channels (TPCs) in endosomal membranes for successful entry (see the Perspective by Falzarano and Feldmann). The Ebola virus could not enter cells lacking TPCs or cells treated with a TPC inhibitor. Blocking TPCs therapeutically allowed 50% of mice to survive an ordinarily lethal Ebola virus infection. — KLM

Science, this issue p. 995;
see also p. 947

IN OTHER JOURNALS

Edited by **Kristen Mueller**
and **Jesse Smith**

Five small rocky planets orbit the star Kepler-444



EXOPLANET DETECTION

Untangling dips and pulses in starlight

The menagerie of known exoplanets continues to grow with Kepler data. The NASA spacecraft has monitored stars for brightness dips due to planetary transits, enabling Campante *et al.* to find five rocky planets orbiting the K star Kepler-444—all between Mercury and Venus in size. Kepler's precise photometry also allowed the team to measure the star's asteroseismic pulsations. A comparison of those values with stellar evolution models revealed an age of 11.2 ± 1.0 billion years, or 80% as old as the universe itself. A planetary system this old (over twice the age of Earth) demonstrates the wide time frame in which Earth-sized planets have existed and helps astronomers discern the earliest times of planet formation. — MMM

Astrophys. J. 10.1088/0004-637X/799/2/170 (2015).

PHYSICS

Hunting the elusive (quasi)particles

Majorana fermions, particles that are their own antiparticles, have not yet been observed in nature. There have, however, been several possible sightings of their counterparts in solid-state systems, which may eventually lead to advances in quantum computing. Xu *et al.* used scanning tunneling

microscopy to observe signatures of these Majorana modes in a system consisting of a conventional superconductor with a topological insulator (TI) layer on top of it. The authors observed a distinct change of the experimental signal as the thickness of the TI layer crossed a threshold value, which they interpreted as evidence for the Majorana modes. — JS

Phys. Rev. Lett. **114**, 017001 (2015).

ALSO IN SCIENCE JOURNALS

Edited by Stella Hurtley

SUSTAINABILITY

Seeking systems-based solutions

Without sustainable solutions, the world's most pressing environmental concerns will continue to persist or worsen. Achieving the goal of sustainability involves so many factors—from economics to ecology—that investigating one or even a handful of variables at a time often overlooks major parts of the problem. Liu *et al.* review systems-based approaches that are beginning to provide tenable ways to assess sustainability. Further integrating coupled human and natural components of a problem across multiple dimensions, including how one solution can create unintended consequences elsewhere, is essential for developing effective policies that seek global sustainability. — NW

Science, this issue p. 963

PLASMA PHYSICS

Shocking! Particle accelerators in space

The acceleration of charged particles to high energies has been a major mystery, with a number of competing theories based on plasma physics. Many include the concept of turbulence, but with different roles. For example, shock-based theories emphasize the importance of turbulence developed from an unstable shock layer, whereas turbulent reconnection theories emphasize interactions of multiple reconnection sites. Matsumoto *et al.* present results of a large particle-in-cell simulation and examine how electrons are accelerated in the transition layer of a fast nonrelativistic shock (see the Perspective by Ji and Zweibel). Surprisingly, they find that when the shock is strong enough, charged particles (electrons in this case) are efficiently accelerated by

turbulent reconnection within a turbulent shock layer containing multiscale structures. — MMM

Science, this issue p. 974;
see also p. 944

GENE REGULATION

Uncaging promoter and enhancer dynamics

In order to understand cellular differentiation, it is important to understand the timing of the regulation of gene expression. Arner *et al.* used cap analysis of gene expression (CAGE) to analyze gene enhancer and promoter activities in a number of human and mouse cell types. The RNA of enhancers was transcribed first, followed by that of transcription factors, and finally by genes that are not transcription factors. — LMZ

Science, this issue p. 1010

ACTUATING MATERIALS

Making small actuators more effective

Liquid-crystal molecules orient locally in response to external fields. When long-chain liquid-crystalline molecules are cross-linked together, changes in local orientation can lead to significant volume changes. Ware *et al.* made efficient microactuators that can change their shape from flat to three-dimensional structures (see the Perspective by Verduzco). By patterning volume elements so that each has a different preferred alignment for the liquid-crystalline molecules, they could fine-tune the volume changes. — MSL

Science, this issue p. 982;
see also p. 949

STEM CELLS

mRNA modification regulates pluripotency

When stem cells progress from an embryonic pluripotent state toward a particular lineage,

molecular switches dismantle the transcription factor network that keeps the cell pluripotent. Geula *et al.* now show that N⁶-methyladenosine (m⁶A), a messenger RNA (mRNA) modification present on transcripts of pluripotency factors, drives this transition. Methylation destabilized mRNA transcripts and limited their translation efficiency, which promoted the timely decay of naïve pluripotency. This m⁶A methylation was also critical for mammalian development. — BAP

Science, this issue p. 1002

CANCER

The downstream effects of false promotion

Special DNA sequences at the ends of chromosomes, called telomeres, are replenished by a dedicated enzyme called telomerase. A subset of human tumors harbors mutations in the promoter region of the TERT gene, which codes for a subunit of telomerase. Borah *et al.* explored the downstream effects of TERT promoter mutations in cells derived from urothelial (urinary tract) cancers. The mutations were associated with aberrantly high levels of TERT mRNA, TERT protein and telomerase activity, and longer telomeres. A small study of clinical samples suggested that high levels of TERT mRNA may be a marker of more aggressive urothelial cancers. — PAK

Science, this issue p. 1006

TRANSCRIPTION

Keeping repressed genes repressed

Hox genes confer positional identity to cells and tissues. Maintaining precise spatial patterns of *Hox* gene expression is vital during metazoan development. The transcriptional repressor CTCF is involved in the regulation of chromatin

architecture. Narendra *et al.* show that a CTCF protein binding site insulates regions of active and repressed *Hox* gene expression from each other. This protects heterochromatin containing repressed *Hox* genes from the encroaching spread of active chromatin. The CTCF protein appears to organize the active and repressed chromatin regions into distinct architectural domains. — GR

Science, this issue p. 1017

EVOLUTION

Losing and then regaining flagella

The ability to adapt to changes in the function of gene regulators, as opposed to structural genes, is a crucial aspect of evolutionary change. Taylor *et al.* mutated a central regulator for the formation of flagella in the bacterium *Pseudomonas fluorescens*. They then put the mutated flagella-free bacteria under strong selection pressure to regain mobility. The mutated bacteria regained the lost flagella, and motility, within 4 days. Two stereotypical mutations diverted an evolutionarily related regulator that normally controls nitrogen uptake to control flagella biosynthesis. The mutations increased the levels of the co-opted regulator, then altered its specificity for the flagella pathway. — GR

Science, this issue p. 1014

INFLAMMATION

Itching to reduce inflammation

The kinase p38 is activated in various inflammatory skin disorders, but drugs that block p38 activity can cause toxicity. Mice deficient in the E3 ubiquitin ligase *Itch* have itchy skin. Theivanthiran *et al.* studied the α isoform of p38 in these mice. Skin cells from *Itch*-deficient mice had more active p38 α and higher levels of

the p38 α -binding protein Tab1. In skin cells from normal mice, Tab1 was targeted for degradation by Itch. Skin inflammation in Itch-deficient mice was decreased after injection with a peptide that blocked the Tab1-p38 α interaction, suggesting an alternative way to target p38 α in inflammatory disorders. — JFF

Sci. Signal. **8**, ra22 (2015).

SOLAR CELLS

Balanced carrier diffusion in perovskites

The efficient operation of solar cells based on inorganic-organic perovskites requires balanced transport of positive and negative charge carriers over long distances. Dong *et al.* used a top-seeded solution growth method to obtain millimeter-scale single crystals of the organolead trihalide perovskite CH₃NH₃PbI₃. Under low light illumination, the electron and hole diffusion lengths exceeded 3 mm, and under full sunlight illumination, they exceeded 175 μ m. — PDS

Science, this issue p. 967

WATER SPLITTING

An enduring catalyst built from carbon

Splitting water into its constituent elements, hydrogen and oxygen, generally requires the assistance of metal catalysts. Liu *et al.* now show that a metal-free hybrid material composed of carbon and nitrogen can promote this reaction all on its own, with the help of some visible light. The photocatalyst combines one material (C₃N₄) known to split water into hydrogen and peroxide with a second material (C₂Dot) that breaks the peroxide down before it can damage the first. The robust stability of this hybrid bodes well for practical implementation of optimized analogs in solar energy storage schemes. — JSY

Science, this issue p. 970