Cross-boundary human impacts compromise the Serengeti-Mara ecosystem

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CONSERVATION ECOLOGY

Threats to the Serengeti

Protected areas are an important tool for conserving biodiversity and ecosystem functioning. But how well do these areas withstand pressure from human activity in surrounding landscapes? Veldhuis et al. studied long-term data from the Serengeti-Mara ecosystem in East Africa. Human activities at boundary regions cause animals to concentrate in the core of the protected area, which eventually reduces soil carbon storage and nitrogen fixation rates and increases vulnerability to extreme droughts. Similar patterns are likely for many, if not all, large protected areas. —AMS

Science, this issue p. 1424

MAGNETISM

Magnetic building blocks in two dimensions

Artificial magnetic structures can offer a variety of functionalities in spintronics devices. Luo et al. engineered magnetic domains in Pt/Co/AlOₓ trilayers that had alternating in-plane and out-of-plane magnetizations. The regions interacted laterally through the so-called Dzyaloshinskii-Moriya interaction, which determined the relative sign and orientation of the magnetization in adjacent domains. Using the coupling between the domains, the researchers were able to engineer more-complex magnetic structures such as skyrmions and frustrated magnets. —JS

Science, this issue p. 1435

WILDLIFE DISEASE

The demise of amphibians?

Rapid spread of disease is a hazard in our interconnected world. The chytrid fungus *Batrachochytrium dendrobatis* was identified in amphibian populations about 20 years ago and has caused death and species extinction at a global scale. Scheele et al. found that the fungus has caused declines in amphibian populations everywhere except at its origin in Asia (see the Perspective by Greenberg and Palen). A majority of species and populations are still experiencing decline, but there is evidence of limited recovery in some species. The analysis also suggests some conditions that predict resilience. —SNV

Science, this issue p. 1459; see also p. 1386

PROTEIN DESIGN

Precise packing for membrane proteins

Although nonpolar amino acid side chains pack efficiently in membrane proteins, it has been difficult to determine how much this contributes to membrane protein stability. Designed membrane proteins have largely relied on other stabilizing interactions such as metal-ligand interactions and hydrogen bonds. Mravic et al. uncovered a steric packing code underlying the folding of the natural protein phospholamban, which they used to design stable membrane proteins with nonpolar interfaces. They suggest that packing of nonpolar residues plays a role in the folding and stability of many membrane proteins. —VV

Science, this issue p. 1418

ORGANIC CHEMISTRY

Crowdsourcing a chromophore

Photoredox catalysis is widely used to accelerate chemical reactions by channeling the energy in visible light. However, most implementations rely on expensive chromophores to absorb light. Fu et al. now show that a pair of cheap components acting in concert can induce these reactions, despite not being strong visible absorbers individually. The combination of sodium iodide and triphenylphosphine allowed...
photoinduced electron transfer to catalyze a variety of alkyations. —JSY

Science, this issue p. 1429

PLANT SCIENCE

Speeding up stomatal responses

A plant’s cellular metabolism rapidly adjusts to changes in light conditions, but its stomata—pores that allow gas exchange in leaves—are slower to respond. Because of the lagging response, photosynthesis is less efficient, and excess water is lost through the open pores. Papanatsiou et al. introduced a blue light–responsive ion channel into stomata of the small mustard plant Arabidopsis. The channel increased the rate of stomata opening and closing in response to light. The engineered plants produced more biomass, especially in the fluctuating light conditions typical of outdoor growth. —PJH

Science, this issue p. 1456

T CELLS

Zooming in on the kiss of death

Cytotoxic T lymphocytes (CTLs) engage and kill antigen-specific target cells by injecting toxic proteins. The toxic proteins, including perforin and granzyme, are stored in lytic granules in the CTLs and are delivered via so-called immunological synapses between the CTLs and target cells. Tamzalit et al. used an in vitro system to generate and visualize three-dimensional immunological synapses. They examined actin dynamics and lytic granule fusion within these synapses and found that granule fusion was physically separated from regions of actin depletion. Their studies shed light on the microscopic details of CTL-driven killing. —AB


RNA SEQUENCING

Gene expression at fine scale

Mapping gene expression at the single-cell level within tissues remains a technical challenge. Rodrigues et al. developed a method called Slide-seq, whereby RNA was spatially resolved from tissue sections by transfer onto a surface covered with DNA-barcoded beads. Applying Slide-seq to regions of a mouse brain revealed spatial gene expression patterns in the Purkinje layer of the cerebellum and axes of variation across Purkinje cell compartments. The authors used this method to dissect the temporal evolution of cell type—specific responses in a mouse model of traumatic brain injury. —LMZ

Science, this issue p. 1463

COMPUTER SCIENCE

Heart-function modeling for the masses

Modeling cardiac dynamics allows scientists to understand individual heart behaviors, such as arrhythmia. These models typically require supercomputers to solve an individualized network of differential equations that capture the fluid dynamics within a heart. Kaboudian et al. translated popular cardiac models to run on graphics processing units, or GPUs, that normally handle image and video processing. The result is a massively parallel simulation that can run quickly inside a web browser on a standard mobile phone. This technology may be broadly applicable to many other computationally expensive biomedical calculations. —KJP and AC


NEUROSCIENCE

The up and down of localization

Grid cells in the entorhinal cortex interact with place cells in the hippocampus to represent the current location of an animal. In the past, experiments were largely performed on rats running across horizontal surfaces. The real world, however, is three-dimensional. It is not known whether the reference plane for the grid cells is horizontal or an animal’s locomotor plane. Casali et al. recorded from place and grid cells while rats moved across a flat surface or climbed up walls. The firing patterns of grid and place cells changed and constantly readjusted when the rat was climbing. —PRS


IN OTHER JOURNALS

Edited by Caroline Ash and Jesse Smith

Moving through the 3D world (in this case a brown rat climbing a bird feeder) requires constant readjustment in the brain.
EARTH SYSTEM
Nanomaterials in the Earth system
Nanomaterials have been part of the Earth system for billions of years, but human activities are changing the nature and amounts of these materials. Hochella Jr. et al. review sources and impacts of natural nanomaterials, which are not created directly through human actions; incidental nanomaterials, which form unintentionally during human activities; and engineered nanomaterials, which are created for specific applications. Knowledge of the properties of all three types as they cycle through the Earth system is essential for understanding and mitigating their long-term impacts on the environment and human health. —JFU
Science, this issue p. 1414

SYNTHETIC BIOLOGY
How to make an organelle in eukaryotes
A key step in the evolution of complex organisms like eukaryotes was the organization of specific tasks into organelles. Reinkemeier et al. designed an artificial, membraneless organelle into mammalian cells to perform orthogonal translation. In response to a specific codon in a selected messenger RNA, ribosomes confined to this organelle were able to introduce chemical functionalities site-specifically, expanding the canonical set of amino acids. This approach opens possibilities in synthetic cell engineering and biomedical research. —SMH
Science, this issue p. 1415

IMMUNOLOGY
Phage subverts immune response
Pseudomonas aeruginosa (Pa) is a multidrug-resistant Gram-negative bacterium commonly found in health care settings. Pa infections frequently result in considerable morbidity and mortality. Sweere et al. found that a type of temperate filamentous bacteriophage that infects and integrates into Pa is associated with chronic human wound infections. Likewise, wounds in mice colonized with phage-infected Pa were more severe and longer-lasting than those colonized by Pa alone. Immune cell uptake of phage-infected Pa resulted in phage RNA production and inappropriate antiviral immune responses, impeding bacterial clearance. Both phage vaccination and transfer of antiphage antibodies were protective against Pa infection. —STS
Science, this issue p. 1416

POLYMERS
The right hand lines up vinyl ethers
Well-optimized catalysts produce vast quantities of isotactic polypropylene, in which the side chains all face the same way. Add an oxygen into the monomer, though, and that degree of uniformity becomes harder to enforce. Teator and Leibfarth report a general protocol to polymerize a variety of such vinyl ethers isotactically (see the Perspective by Foster and O’Reilly). They rely on a chiral phosphoric acid in combination with a titanium Lewis acid to bias the monomer orientation during cationic polymerization. The resulting polymers show promising adhesive properties. —JSY
Science, this issue p. 1439; see also p. 1394

IMMUNOMETABOLISM
Stemness against adversity
T lymphocytes are powerful immune cells that can destroy tumors, but cancers have developed tricks to evade killing. Vodnala et al. found that potassium ions in the tumor microenvironment serve a dual role of influencing T cell effector function and stemness (see the Perspective by Baixauli Celda et al.). Increased potassium ions impair T cell metabolism and nutrient uptake, resulting in a starvation state known as autophagy. The increased potassium can also preserve T cells in a stem-like state where they retain the capacity to divide. These seemingly divergent processes are linked to the cellular distribution of acetyl–coenzyme A, which, when manipulated, can restore the ability of human T cells to eliminate tumors in mice. —PNK
Science, this issue p. 1417; see also p. 1395

NEUROSCIENCE
Reward and the map in the brain
Recent findings suggest a more complex role of grid cells in the brain than simply coding for space. The grid map in the entorhinal cortex, which is responsible for encoding spatial information, is not as rigid as originally thought and can be distorted by environmental modifications (see the Perspective by Quian Quiroga). Butler et al. compared grid cell coding during a free-foraging task and a spatial memory task in rats. They discovered that entorhinal spatial maps restructure to incorporate the location of a learned reward. Boccara et al. tested the influence of behaviorally relevant information on the cognitive map that emerges from grid cell firing in the rat medial entorhinal cortex. They found that grid cells participate in neural coding of the goal locality, not the whole environment. —PRS
Science, this issue p. 1447, p. 1443; see also p. 1388

CONSERVATION
More than just numbers
We often frame negative human impacts on animal species in terms of numbers of individuals reduced or numbers of regions from which species are absent. However, human activities are likely affecting species in more complex ways than these figures can capture. Kühl et al. studied behavioral and cultural diversity in our closest relative, the chimpzanze. They found that human-mediated disturbance is reducing these complex traits. Human influence thus goes well beyond simple loss of populations or species, leading to behavioral change even where populations persist. —SNV
Science, this issue p. 1453

BIOTECHNOLOGY
Endogenous gene editing
Genetically modified crops have supporters and opponents, but how can these views be reconciled to improve food security? This problem is particularly acute for middle-income countries that need to export crops to maintain their economy as well as provide for their expanding population. In a Perspective, Zaidi et al. discuss the promise of new plant breeding technologies to edit endogenous genes in crop plants. These innovations will ideally improve food security and avoid barriers to use and implementation that face traditionally genetically modified crops. —GKA
Science, this issue p. 1390

LAW
Recognizing rights to protect nature
Laws aimed at preventing harm to the environment appear to be insufficient to halt or reverse environmental destruction. In a Perspective, Chapron et al. highlight recent efforts to recognize intrinsic rights of nature. Going
beyond the rights for individuals supported by animal rights advocates, the rights-of-nature proponents focus on natural communities, ecosystems, and other natural entities. These rights provide a means to protect natural entities when their needs conflict with those of humans. Successful expansion and implementation of this concept will depend on the ability of legal systems to integrate ecological knowledge and balance the rights of nature with those of humans or corporations. —JFU

Science, this issue p. 1392

**CYSTIC FIBROSIS**

**Tackling cystic fibrosis in the womb**

Cystic fibrosis (CF) is a multi-organ disease caused by mutations in the cystic fibrosis transmembrane conductance regulator (CFTR). Abnormalities in the lungs, pancreas, and gastrointestinal tract develop even before birth. Sun et al. reasoned that early intervention using the approved drug VX-770 (ivacaftor), a CFTR modulator, could prevent the development of such abnormalities. They tested the effect of in utero and early postnatal VX-770 administration in a ferret model of CF. Organ pathologies were partially prevented in treated ferrets, suggesting that prenatal treatment might increase the efficacy of CFTR-correcting therapies. —MM


**FERTILITY**

**Protamine modification for fertility**

During the final stage of spermatogenesis, small, positively charged proteins known as protamines tightly package DNA in the mature sperm. Itoh et al. found that mice deficient in the heat shock protein Hspa4l, which is implicated in spermatogenesis, produced sperm with malformed heads and were sterile. Hspa4l kept protamine 2 dephosphorylated at a specific serine residue. Expression of an unphosphorylatable protamine 2 mutant reversed the infertility of Hspa4l-deficient mice, suggesting a pathway that could be targeted for fertility or contraceptive purposes. —JFF