RESEARCH

IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

The Sunda pangolin, *Manis javanica*, is critically endangered owing to poaching and illegal trade.

WILDLIFE TRADE

A heavy toll

Trade in wildlife, and their parts, is well recognized for a few key species, such as elephants and rhinos, but it occurs globally, across a wide array of species. Scheffers *et al*. looked across tens of thousands of vertebrate species and found that one in every five species is affected by trade of some sort. The impacts of trade tend to be concentrated in certain phylogenetic groups, thus the potential for long-term impact on certain lineages is substantial. This analysis allows for prediction of potential for trade where it does not yet occur, facilitating proactive prevention. —SNV *Science*, this issue p. 71

ATOMIC PHYSICS

Building up an optical clock

Arrays of optical tweezers can be used to trap atoms, which can then be manipulated individually. Such arrays have shown promise in quantum simulation of many-body systems. Norcia *et al*. now demonstrate that they can also be used as a platform for optical clocks. The researchers lined up 10 optical tweezers in a one-dimensional array, where each tweezer held either one or zero atoms of strontium. The atoms were subjected to laser light whose frequency was tuned to a clock transition in strontium. By monitoring the number of atoms in each tweezer, the researchers measured a long coherence time of a few seconds. Increasing the number of tweezers should improve the figures of merit of this platform. —JS

Science, this issue p. 93

STAR FORMATION

Gas flows and disks in a young binary

Many stars are in binary systems, pairs of stars gravitationally bound to each other, often with the two components having similar masses. It remains unclear how these systems assemble and accrete material. Alves *et al*. made high-resolution observations of a young binary star that is still in the process of forming. A large disk surrounds both stars, and each component also has its own smaller circumstellar disk. Spiral filaments of dust and gas connect the small disks to the larger one. Material is accreting preferentially onto the star that currently has a lower mass, driving the masses toward similar values. —KTS

Science, this issue p. 90

NEUROPROSTHETICS

Good vibrations

The lack of sensory feedback from the leg prosthesis in lower limb amputees is associated with risk of falls, low mobility, and perception of the prosthesis as an external object. Petrini *et al*. tested a leg neuroprosthesis, which provided real-time on-demand tactile sensory feedback through nerve stimulation in three transfemoral amputees. Stimulation improved mobility, decreased falling episodes, and increased the perception of the prosthesis as part of the body. Active complex tasks were accomplished with reduced effort when nerve stimulation was turned on. —MM

Sci. Transl. Med. **11**, eaav8939 (2019).

BIODIVERSITY LOSS

Staggering decline of bird populations

Because birds are conspicuous and easy to identify and count, reliable records of their occurrence have been gathered over many decades in many

PHOTO: SUZI ESZTERHAS/MINDEN PICTURES

parts of the world. Drawing on such data for North America, Rosenberg *et al*. report widespread population declines of birds over the past half-century, resulting in the cumulative loss of billions of breeding individuals across a wide range of species and habitats. They show that declines are not restricted to rare and threatened species—those once considered common and widespread are also diminished. These results have major implications for ecosystem integrity, the conservation of wildlife more broadly, and policies associated with the protection of birds and native ecosystems on which they depend. —AMS

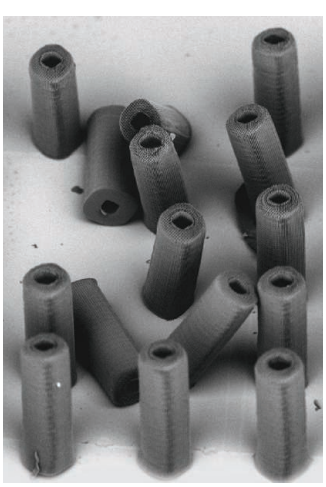
Science, this issue p. 120

3D PRINTING

Speeding up submicrometer printing

Using light to build three-dimensional structures with photopolymerization is the basis for two-photon lithography. However, there has been a trade-off between speed and resolution for fabricating structures with this method. Saha *et al*. optimize a new parallel printing methodology that relies on ultrafast lasers. They show the ability to dramatically increase the speed of printing while maintaining submicrometer resolution. —BG

Science, this issue p. 105



3D printed pillars with submicrometer features

PHOTOS (LEFT TO RIGHT): VU NGUYEN AND SOURABH SAHA; DULYANUT SWDP/GETTY IMAGES

STRUCTURAL BIOLOGY

The yin and yang of Raf inhibition

Many human melanomas contain an overactive form of Raf kinase (B-Raf). Inhibitors are effective against the mutant B-Raf, but, paradoxically, they activate wild-type B-Raf, limiting their therapeutic potential. Kondo *et al*. determined the structure of a phosphorylated B-Raf dimer in complex with the scaffold protein 14-3-3 by cryo–electron microscopy. Although both kinases are in the active conformation, one is blocked by the C-terminal tail of the other. This configuration inhibits one active site but also stabilizes the dimer in the active conformation. Understanding this mechanism provides a framework for development of inhibitors that do not activate wild-type Raf. —VV

Science, this issue p. 109

ATMOSPHERIC SCIENCE

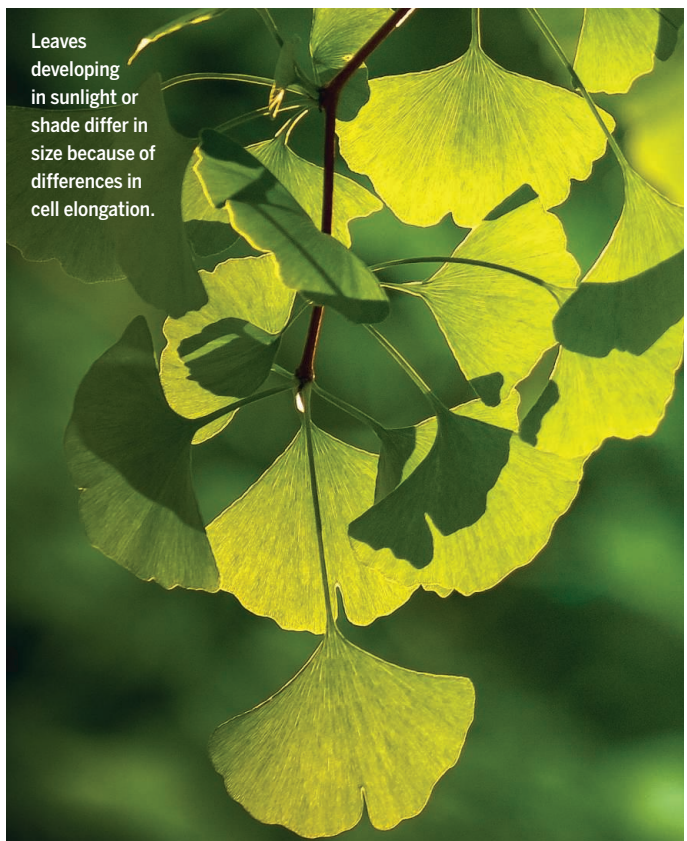
Consequences of nuclear war

The likely catastrophic environmental effects of global nuclear war are well-described in the scientific literature, but the effects of a more limited, regional nuclear war are also staggering. Toon *et al.* combined a realistic war scenario involving the neighboring, nuclear-capable nations of India and Pakistan with established climate models to explore plausible global effects of such conflict. These models suggest that, in addition to human casualties, an India-Pakistan nuclear war would start fires releasing tens of trillions of grams of black carbon into the stratosphere. Distributed globally, this soot would limit the amount of sunlight that reaches Earth's surface, drastically reducing surface temperatures and thus potentially limiting food supplies globally for more than a decade. —KH

Sci. Adv. 10.1126/sciadv.aay5478 (2019).

IN OTHER JOURNALS

Edited by **Caroline Ash** *and* **Jesse Smith**



Leaves developing in sunlight or shade differ in size because of differences in cell elongation.

PLANT SCIENCE

Light tuning of leaf size

The *Arabidopsis* plant, when grown under intense light, develops thicker leaves than when grown under dim light. Hoshino *et al.* parse the various processes involved. Cell elongation and organized divisions underpin the thickness of leaves growing in intense light. Later in development, cell expansion and increases in intercellular spaces finalize the respective dimensions of leaves growing in sunlight or in shade. Blue-light signaling drives initial unequal cell elongation in sun-exposed leaves, whereas sucrose, a photosynthetic product, promotes the late phase of leaf thickening for both sun-exposed and shaded leaves. With leaf development linked to environmental signals, the plant's leaf structure can be fine-tuned to best suit its microenvironment. —PJH

Plant J. 10.1111/tpj.14467 (2019).

STELLAR ASTROPHYSICS

An ancient star missing its iron

The Big Bang produced only hydrogen, helium, and traces of lithium. Heavier elements were forged within the first generation of stars, which then exploded as supernovae. A second stellar generation formed from gas polluted by those supernovae, and some of those stars are still around today. Nordlander *et al.* discovered a star with an extremely small amount of iron, much more carbon, and low abundances

ALSO IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

PREBIOTIC CHEMISTRY

Conditions right for making nucleosides

In the absence of biological catalysts and metabolism, can atmospheric and geochemical processes provide the substrates and conditions required for production of biological molecules? Becker *et al*. devised an abiotic synthetic scheme that allows for accumulation of both purine and pyrimidine nucleoside mono- and diphosphates (see the Perspective by Hud and Fialho). A key starting material for this chemistry, hydroxylamine and/or hydroxylamine disulfonate, can form under plausible early atmospheric conditions. Cycles between wet and dry conditions provide the environments necessary to complete formation of purine and pyrimidine bases essentially in one pot. —MAF

Science, this issue p. 76; see also p. 32

SONG LEARNING

An imitation circuit

Animals, including humans, rely heavily on imitation and social learning, yet we know little about how this process operates in the brain. Zhao *et al*. used optogenetic manipulation of a synaptic pathway connecting auditory and vocal motor circuits to implant song memories sufficient to guide song learning into young zebra finches (see the Perspective by Clayton). Activation of this circuit overrode learning from live tutors. These experiments define circuits essential for social learning of songs from tutors and show that such memories can be localized. —SNV

Science, this issue p. 83; see also p. 33

INTERGALACTIC MEDIUM

Glowing filaments of the cosmic web

Most gas in the Universe lies in the intergalactic medium, where it forms into sheets and filaments of the cosmic web. Clusters of galaxies form at the intersection of these filaments, fed by gas pulled along them by gravity. Although this picture is well established by cosmological simulations, it has been difficult to demonstrate observationally. Umehata *et al*. mapped emission from the intergalactic medium in an area around galaxies that are starting to form a cluster (see the Perspective by Hamden). They found that the gas is arranged into filaments, whose position and velocity correlate with star-forming galaxies, supporting the theoretical picture. —KTS

Science, this issue p. 97; see also p. 31

QUANTUM PHYSICS

A test of quantum gravity

Quantum mechanics and the general theory of relativity represent two pillars of modern physics, but unification of the two theories remains an open problem. Theories of quantum gravity abound, but they tend to lack an experimental foundation. One such proposed theory, event formalism, predicts that a pair of entangled particles decorrelate as they pass through different regions of the gravitational well of a planetary object. Xu *et al*. present results of a quantum optical test of this proposal using the quantum satellite Micius. Using entangled photon pairs, one sent to the satellite and the other retained on Earth, they find no evidence for the predicted decorrelation effects. The results may help shed light on the interplay between quantum theory and gravity. —ISO

Science, this issue p. 132

FOREST ECOLOGY

Fungal influence on density dependence

Tree species in highly diverse tropical forests tend to exhibit conspecific negative density dependence, a phenomenon whereby individuals of the same species tend to grow at a distance from one another. This is understood to be a key driver of species coexistence. The strength of negative density dependence varies between species, but the mechanisms driving this variation are unknown. Chen *et al*. studied tree species in a subtropical forest in China and found an important role for soil-dwelling fungi in this variation. Elevated accumulation of pathogenic fungi leads to stronger negative density dependence, whereas elevated accumulation of mutualistic fungi leads to weaker negative density dependence. —AMS

Science, this issue p. 124

LIPID METABOLISM

Distant cousin helps spot animal enzyme

In addition to forming the membranes that enclose cells, lipids are important signaling molecules. Plasmalogens, which contain a vinyl ether linkage, are an abundant group of lipids in animals. How these lipids are synthesized from precursors with an alkyl ether linkage has been a mystery. Gallego-García *et al*. found an enzyme, CarF, in the social bacterium *Myxococcus xanthus* that produces plasmalogens used in a signaling pathway for singlet oxygen, a marker of photooxidative stress. They then showed that the animal homolog could catalyze the final step in plasmalogen synthesis in bacterial and human cells, thus resolving a source for plasmalogens in animals. —MAF

Science, this issue p. 128

RESPIRATORY ENZYMES

Hemes switch spots in a terminal oxidase

Reduction of molecular oxygen to water is the driving force for respiration in aerobic organisms and is catalyzed by several distinct integral membrane complexes. These include an exclusively prokaryotic enzyme, cytochrome bd–type quinol oxidase, which is a potential antimicrobial target. Safarian *et al*. determined a high-resolution cryo–electron microscopy structure of this enzyme from the enteric bacterium *Escherichia coli*. Comparison to a homolog reveals a complete relocation of the site of oxygen binding and reduction caused by a change in the arrangement of heme cofactors and channels in the protein scaffold. This switch illustrates the diversity of structure and function in this family of enzymes and might reflect different biochemical roles of these homologs. —MAF

Science, this issue p. 100

CHROMATIN BIOLOGY

Twisting DNA to move it

A key regulatory aspect of DNA is how tightly it is wrapped around nucleosomes, the histone cylinders that help package DNA. The exposure of DNA determines accessibility of proteins, such as transcription factors and DNA methyltransferases, which in turn regulate gene expression and cell identity. How can DNA be unwound from nucleosomes to modulate gene expression? In a Perspective, Bowman and Deindl discuss recent advances in understanding the mechanism by which DNA movement around nucleosomes occurs. Nucleosome remodelers pull on the DNA strands to influence how the helix is twisted, which allows the strands to move around the nucleosome. Similar mechanisms might also exist for other protein complexes that move along DNA. —GKA

Science, this issue p. 35

SYSTEMS BIOLOGY

Protein competition drives cell fate

Cell survival can require switching mechanisms that are flexible enough to accommodate environmental changes but also stable for the required duration. Lord *et al*. created a switching system in bacteria based on stochastic competition between two proteins: one is a transcriptional repressor, and the other is an antagonist that binds the repressor and locks it in an inactive state. They show that this system controls switching of the bacterium *Bacillus subtilis* from a motile, unicellular state to an immobile, multicellular state, and that the control system is transferable to another distantly related bacterium. Similar mechanisms could be more widely operable in biological systems than previously recognized. —LBR

Science, this issue p. 116

CANCER THERAPY

Targeting a kidney cancer

People with von Hippel-Lindau syndrome, caused by loss of the gene *VHL*, are at an increased risk of developing clear cell renal cell carcinoma (ccRCC). Currently, drugs that inhibit the transcription factor HIF-2α show some efficacy but not in all patients. Nicholson *et al*. performed a screen to identify targets that limited tumor growth in a *VHL* double-knockout fly model. They discovered that inhibiting the cyclin-dependent kinases CDK4 and CDK6 together impaired tumor growth in this model regardless of HIF-2α dependency, and they confirmed these results in human ccRCC cells and patient-derived xenografts in mice. —LKF

Sci. Signal. **12**, eaay0482 (2019).

LYMPHOCYTES

Sending B cells back in time

B-1 cells are a subset of self-reactive B cells that arise in early life. Precisely how and why the immune system permits the development of self-reactive B cells in neonates remains a mystery. By studying B cell development in neonatal mice, Vanhee *et al.* uncovered the importance of RNA binding protein Lin28b in facilitating positive selection of self-reactive B-1 cells in neonates. They also found that ectopic expression of Lin28b was sufficient to promote selection of self-reactive B-1 cells in adult mice. The authors propose that Lin28b functions as a cell-intrinsic switch that jumpstarts the generation of B cells in early life. —AB

Sci. Immunol. **4**, eaax4453 (2019).