ECOLOGY/EVOLUTION

Fishing Induces Regime Change

The speed of change in ecosystems ranges from the imperceptible to the abrupt. Rapid, nonlinear changes (referred to as regime shifts) over time scales as short as 1 year are by their nature difficult to study and even more difficult to attribute to specific causes. Nevertheless, the accumulation of data over periods of decades can provide critical tests of mechanistic proposals.

Using time series data from fishery catches, long-term monitoring of plankton and planktivorous fish biomass, and oxygen concentration measurements over the past 50 years, Daskalov *et al.* describe two major regime shifts and several minor ones in the Black Sea ecosystem. Predatory fishes were heavily depleted in the 1960s, causing a cascade of effects down the food chain in the 1970s whereby top-down consumer control was replaced by bottom-up resource control of the system, which became dominated by planktivorous fishes. A second major shift happened in the early 1990s, when there was a population collapse of planktivorous fishes and an outburst of an alien jellyfish *Mnemiopsis leidyi*. The time series data suggest overfishing as the driver of both of these shifts, rather than pollution or the alien invasion per se. The top trophic level of predatory fish has not recovered (and seems unlikely to), although the appearance of the jellyfish *Beroe ovata*, which preys on *M. leidyi*, may promote the recovery of the next highest trophic layer of planktivorous fish. — AMS

Proc. Natl. Acad. Sci. U.S.A. **104**, 10518 (2007).

IMMUNOLOGY

The Markings of Diversity

Antibody diversity in B cells is achieved through the somatic rearrangement of variable-(diversity)-joining [V(D)J] genetic segments. Allelic exclusion ensures that only one recombined allele is expressed in a given cell, in part through the selective acquisition of epigenetic marking by demethylation of the allele that is to undergo rearrangement.

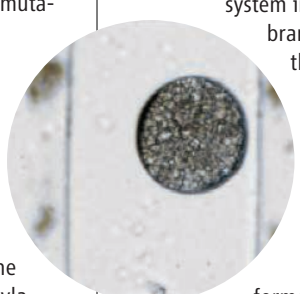
Fraenkel *et al.* show that a second major mechanism, which further enhances antibody diversity and is known as somatic hypermutation (SHM), is under the same allele-restricted control. They generated mice in which developing B cells were engineered to carry a pre-rearranged antibody kappa light chain at both alleles. In these cells, both alleles, rather than only one, were expressed, yet demethylation and extensive hypermutation were confined to just one of the two. Thus, although differences in methylation did not influence the level of transcription after recombination (explaining how both rearranged alleles could be expressed in this system), these differences did correspond to SHM levels. The findings suggest that the same epigenetic marking system that mandates monoallelic expression of productively recombined alleles also targets the rearranged antibody genes for further mutation, and that this discrimination occurs independently of transcription in mature B cells. — SJS

Nat. Immunol. **8**, 715 (2007).

CHEMISTRY

Drying and Wetting Droplets

Exploring the phase relations of complex solutions requires a convenient means of systematically varying the component concentrations. In this vein, Shim *et al.* developed a microfluidic system in which permeable membranes facilitate variation of the water composition of solute-containing droplets. Surfactant-stabilized aqueous droplets are formed in an oil stream, and the flat rectangular cross-section of the channels causes the droplets to adopt a disklike shape, so that their area changes with droplet volume. A droplet is then maneuvered into a region where the channel is connected to a reservoir via a poly(dimethylsiloxane) membrane. The reservoir can be filled either with dry air to shrink the droplet and concentrate the solute, or with water to expand the droplet and dilute the solute. This system was used to determine the aqueous phase diagram of poly(ethylene glycol) (PEG) and ammonium sulfate and to study regions of nucleation and growth of protein crystals (lysozyme) from solutions containing salts and PEG. — PDS



Droplet concentration, leading to crystallization.

J. Am. Chem. Soc. **129**, 10.1021/ja071820f (2007).

ASTROPHYSICS

Guiding the Gravity Wave Search

General relativity predicts that when massive objects crash into each other, they should emit ripples in the spacetime fabric called gravitational waves. Detection of these waves is an eagerly pursued but as yet elusive goal. The merger of binary black holes is one example of a powerful event that has been well studied theoretically in the hopes of identifying a clear gravitational wave signature. Supernovae and collapsing stars may also provide strong gravitational wave signals and thus an enlarged set of targets for detection. Dimmelmeier *et al.* performed computer simulations of fusion-burning stars progressing toward their golden years as nonburning neutron stars. The authors paid special attention to the particularly strong gravitational wave burst expected just after collapse, as the infalling material slams against the hard iron core

CREDITS (TOP TO BOTTOM): GEORGE GRALL; SHIM *ET AL.*, *J. AM. CHEM. SOC.* **129**, 10.1021/JA071820F (2007)

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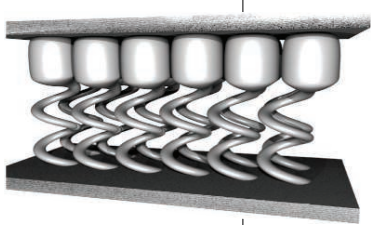
of the dying star. Exploring a wide range of parameters, they found a clear set of waveform templates that should expedite the search for gravitational waves. — DV

Phys. Rev. Lett. **98**, 251101 (2007).

APPLIED PHYSICS

Lightly Sprung

In a Fabry-Pérot interferometer, two closely spaced reflective surfaces cause multiple reflections and only partial transmission of an incoming light beam, leading to multiple interfering transmitted waves. Adjusting the distance between the mirrors finely tunes the transmitted spectrum—a useful technique in optical analysis. Dice *et al.* manufactured a nanospring-based interferometer (shown below) through glancing angle deposition of the organic material tris(8-hydroxyquinoline) aluminum (Alq_3). The springs were deposited between conducting aluminum layers that transmitted ~80% of incident light. A 6-V potential compresses the springs by 1.2 nm, shifting the peak transmission wavelength by 1.6 nm. Because Alq_3 is much softer than silicon dioxide, a material previously used for nanospring fabrication, the extensive compression does not induce breakdown of the springs. Envisioned applications include a movable mirror element in microelectrochemical systems and a pressure-sensitive optical transducer. — MSL



Appl. Phys. Lett. **90**, 253101 (2007).

CHEMISTRY

Convoluted Chromatography

A drawback of chromatographic separations is the waiting time necessary for analytes to travel from the injection site to the detector. High-throughput screens are often limited by this waiting period, during which isolated signal peaks punctuate a largely silent detection baseline. Recently, spectroscopic analysis has benefited from sophisticated mathematical algorithms that facilitate deconvolution of many overlapping signals from a single data set, thereby allowing multiple samples to be analyzed all at once. Trapp has implemented a similar multiplexing approach to gas chromatography. Specifically, he assigned a distinct binary injection sequence to each sample (with each "1" prompting injection and each "0" no action). Multiple samples were then injected continuously onto a separation column in accord with their assigned bar-code sequence, resulting in a much higher proportion of detected signals during a given time period than in traditional chromatography. The overlapping data could be deconvolved into individual chromatograms by means of a Hadamard transform and subsequent matrix manipulations. The author analyzed samples composed of several organic alcohols and hydrocarbons as a proof-of-principle and noted an enhancement in efficiency of nearly a factor of 40. — JSY

Angew. Chem. Int. Ed. **46**, 10.1002/anie.200605128 (2007).

<< A Painful Role for Ankyrin Repeats

Transient receptor potential (TRP) channels are nonselective cation channels that sense heat and noxious chemicals, and hence are important in nociception. One family member, TRPV1, responds to capsaicin, the "hot" ingredient of chilli peppers. TRP channel activity is reduced by either desensitization (after prolonged exposure to a single stimulus) or tachyphylaxis (after sequential exposures to the same stimulus). Increased intracellular Ca^{2+} desensitizes TRPV1 currents, and this desensitization may be mediated by the calcium-binding protein calmodulin (CaM). Lishko *et al*. solved the crystal structure of the ankyrin repeat domain (ARD) found in the N terminus of TRPV1. They discovered that adenosine 5′-triphosphate (ATP), present in the crystallization solution, bound to the ARD. ATP-agarose formed a complex with purified TRPV1-ARD, which was inhibitable by free ATP. Patch-clamp assays of TRPV1-expressing cells showed that ATP sensitized TRPV1 and reduced tachyphylaxis after repeated exposure to capsaicin. Surprisingly, mutation of residues in the ATP-binding site generated mutant TRPV1 channels that had reduced tachyphylaxis, even in the absence of ATP. This suggested that another factor that promotes tachyphylaxis must bind to the same site on TRPV1, and that mutations of this site would result in a net decrease in tachyphylaxis. Exclusion chromatography analysis showed that CaM formed a complex with TRPV1-ARD that was Ca^{2+}-dependent and inhibitable by ATP. Together, these data reveal how the ARD of TRPV1 supports the sensitizing effect of ATP and the inhibitory effect of CaM. — JFF

Neuron **54**, 905 (2007).

CREDIT: DICE *ET AL.*, *APPL. PHYS. LETT.* **90**, 253101 (2007)