EDITED BY KRISTEN MUELLER AND JAKE YESTON

ECOLOGY

DNA Leaves a Trace

Detecting the presence of populations of rare and threatened animal species is a challenge for conservation planners and managers, especially in habitats like lakes and rivers, where an animal leaves little or no macroscopic trace. Thomsen *et al*. have developed a molecular solution to tracking and quantifying elusive creatures, in the form of DNA obtained from water samples in freshwater habitats in Europe. Their trials used six aquatic species—vertebrate and invertebrate—that occur naturally at low abundance and that are the focus of strict conservation efforts. With samples as small as 15 ml, they were able to detect and quantify populations of each species and to verify experimentally that the DNA indeed represented contemporary occurrence. The technique was then successfully extended to the detection of entire communities of species, using high-throughput sequencing techniques. — AMS

Mol. Ecol. 10.1111/j.1365-294X.2011.05418.x (2011).

ENVIRONMENTAL SCIENCE

Not-So-Quicksilver

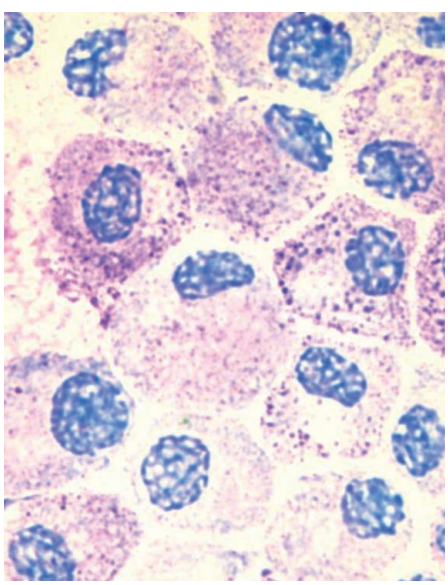
In aquatic or subsurface environments, sulfate-reducing bacteria mediate the transformation of inorganic divalent mercury into highly toxic, bioavailable methylmercury (MeHg), but it is unclear how this reaction depends on the phase of the Hg(II). Zhang *et al.* examined the degree to which sulfate-reducing bacteria methylated three forms of Hg(II), representing different size fractions and different states of aging: dissolved Hg(II) ions, 3- to 4-nm-diameter HgS nanoparticles, and >500-nm HgS particles. The bacteria methylated dissolved Hg(II) fastest, but there were also significant differences between nanoparticles and larger particles of HgS that were attributed to size-dependent crystallinity differences and not simply the amount of reactive surface area. Furthermore, aging HgS nanoparticles—which transformed them into larger HgS particles over time—resulted in less MeHg formation as well, suggesting that methylation is related to the intermediate Hg(II) phases present and the crystal growth kinetics. These observations may help explain the varying production rates of MeHg in the environment. — NW

Environ. Sci. Technol. 10.1021/es203181m (2011).

IMMUNOLOGY

Mast Cells Revisited

Although the role of mast cells in allergic disease is well established, they have also been implicated in responses to bacterial infections, autoimmunity, and cancer. Nearly all of these studies relied on the use of mice containing mutations in the receptor tyrosine kinase Kit, which is important for mast cell development. Although these mice lacked mast cells, Kit is also expressed in other cell lineages and Kit mutant mice suffered from anemia, neutropenia, and impaired lymphocyte development,



among other defects. Feyerabend *et al.* now describe mice (called Cre-Master) with a selective deficiency in mast cells that were generated by the targeted insertion of Cre recombinase into the mast cell carboxypeptidase A3 locus. The insertion of Cre caused deletion of mast cells by genotoxic stress. Cre-Master mice were devoid of mast cells and, as expected, were unable to mount IgE-mediated anaphylactic responses. In contrast to Kit mutant mice, Cre-Master mice were susceptible to antibody-induced autoimmune arthritis. Thus, the function of mast cells, one of the more enigmatic cells of the immune system, may need to be reevaluated. — KLM

Immunity **35**, 832 (2011).

BIOCHEMISTRY

It Takes Three to Copy

The replisome is a complex molecular machine that uses cellular DNA as a template to produce an identical copy. Because of the orientation of the two DNA strands relative to the working direction of the polymerase, the leading strand is synthesized continuously, but the lagging strand is synthesized in segments termed Okazaki fragments. The bacterial replisome was long assumed to contain two polymerases, one each for the lagging strands. Recent studies, however, have provided evidence for three polymerases at *Escherichia coli* replication forks. Why three polymerases would be required remained unclear. Georgescu *et al*. prepared replisomes containing either two or three polymerases and used single-molecule total internal fluorescence microscopy to monitor DNA synthesis. Tripolymerase replisomes were more processive than dipolymerase replisomes, synthesizing products that were nearly twice as long. Differences in DNA synthesis were greater on the lagging than the leading strand, and examination of DNA products showed that the dipolymerase replisome left single-strand gaps, whereas the tripolymerase replisome filled in the lagging strand much more efficiently. On the basis of single-molecule experiments that directly probe

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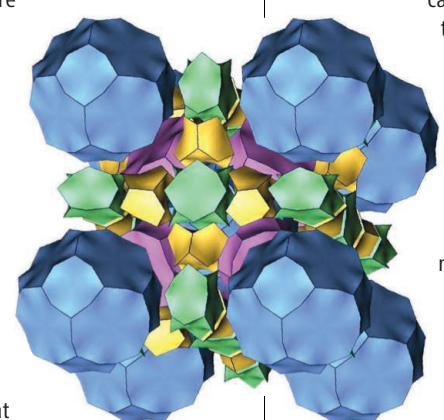
the dynamics of single proteins, it was recently suggested that a new polymerase is used to synthesize each Okazaki fragment during *E. coli* in vivo replication (see Lia *et al.*, Reports, *Science* Express, 22 December 2011). — VV

Nat. Struct. Mol. Biol. 10.1038/nsmb.2179 (2011).

CHEMISTRY

Sugary Networks

The burgeoning development of metal organic framework (MOF) solids has primarily relied on the versatile coordination geometries of transition metal ions, which function as lattice nodes bridged in several dimensions by multifunctional ligands. Forgan *et al.* present an in-depth study of a very different class of solids that still fall under the MOF rubric. Alkali cations such as potassium and rubidium replace the traditional transition metals, and the organic components are γ-cyclodextrins—rings of eight covalently tethered sugar molecules better known for one-dimensional encapsulation than for network formation. Body-centered cubic frameworks were crystallographically characterized and proved robust to removal of solvent after their self-assembly in solution. The use of smaller sodium or larger cesium ions led to several different polymorphs, as did divalent strontium, though transition metals proved poor at directing assembly. Among the potassium-linked variants prepared by the authors was a MOF composed entirely of food-grade materials. — JSY



CREDIT: FORGAN *ET AL.*, *J. AM. CHEM. SOC.* 10.1021/JA208224F (2011)

J. Am. Chem. Soc. 10.1021/ja208224f (2011).

NEUROSCIENCE

Fine-Tuning Neuronal Networks

The double-stranded RNA-activated protein kinase (PKR) is widely present in vertebrates, and its activation leads to the phosphorylation of several substrates, the major known cytoplasmic target being the translation initiation factor eIF2α. PKR is activated in response to a variety of cellular stresses such as viral infection and status epilepticus, and in degenerating neurons in, among others, Huntington's, Parkinson's, Alzheimer's, and Creutzfeldt-Jakob's disease. At present, little is known about its role in normal neuronal function. Using transgenic mice, electrophysiology, immunohistochemistry, and behavioral analysis, Zhu *et al.* discovered that loss of PKR or pharmacological blockade of PKR activity in mice promoted hyperexcitability in cortical and hippocampal networks and enhanced long-lasting synaptic potentiation and long-term memory. PKR regulated these processes via selective control of GABAergic synaptic transmission mediated by interferon-γ (IFN-γ). These findings thus uncovered a new molecular signaling pathway that regulates network rhythmicity, synaptic plasticity, and memory storage in the adult brain. PKR is activated in various neuropathies and may therefore be a potential therapeutic target. — PRS

Cell **147**, 1384 (2011).

HYDROLOGY

A Belgian Water Forecast

Climate change is often discussed in global terms. However, responding to and planning for it requires extending global models to the local level, and assessing impacts on a variety of local resources, such as ecosystems or seasonal water supply, that may have a complex response to the main variables, such as temperature and precipitation. Many uncertainties are associated with such downscaling, regarding how to extend the models and how to assess the local variability in, for instance, precipitation in a future climate. However, approaches are increasingly being developed to consider and explore these uncertainties explicitly, as well as to incorporate ranges of future variability into planning both in the near term and for longer periods. Goderniaux *et al.* illustrate such an approach for assessing the future of groundwater resources in the Geer Basin in Belgium, an important local source of drinking water. In their approach, the authors use the relative change between two global and six regional models, rather than the absolute predicted climates, to build up a stochastic set of future records in key parameters affecting the hydrology of the basin. This allows a probabilistic assessment that can more explicitly represent uncertainties for managers. Overall, they suggest that the climate change signal may dominate normal variability by the later part of this century. Mean groundwater levels are projected to decrease by about 10 m. — BH

Water Resources Res. **47**, W12516 (2011).