

ECOLOGY/EVOLUTION

Globalization via Drift

The evolutionary consequences of plate tectonic movements on biological organisms are often hard to reconstruct. The twin processes of extinction and dispersal tend to obscure biogeographical patterns that might otherwise be interpreted straightforwardly in the context of continental drift. The ideal group of organisms for such a study would be one that is ancient (originating before the breakup of Pangaea roughly 200 million years ago), that disperses poorly or not at all, and that still survives worldwide. Boyer *et al.* have focused on Cyphophthalmi—a suborder of the spiderlike long-legged harvestmen that inhabit leaf litter—which originated around 400 million years ago. A phylogeny constructed from DNA sequence data shows that almost all families of these harvestmen show clear biogeographical patterns that can be traced backward to the breakup and dispersal of the major land masses and continental islands. Relationships between the families suggest that the New Caledonian fauna (Troglosironidae) is more closely related to that of the former Gondwanan tropics (Neogoveidae) than to those of Australia and New Zealand, and this shared origin explains why they both exhibit the unusual row of teeth on the second walking-leg claw. — AMS

J. Biogeogr. **34**, 10.1111/j.1365-2699.2007.01755.x (2007).

CHEMISTRY

Reduced by the Main Group

The addition of H₂ across C=O and C=N multiple bonds has tended to require help from transition metals to coax the process along by first slicing through the bond connecting the two H atoms. An unusual metal-free complex, composed of phosphorus and boron centers bridged by a fluorinated phenyl ring, was recently also shown to reversibly cleave H₂—ostensibly by proton addition to P and hydride transfer to B. Chase *et al.* have now found that, like transition metal complexes, this main group compound acts as an effective catalyst for hydrogenation of CN bonds in aziridines and sterically encumbered imines. The reaction is fastest when electron-donating substituents raise the basicity of the imine nitrogen, implicating a mechanism involving initial proton transfer from the P center. Nitriles and less bulky imines blocked catalysis by coordinating tightly to the B center but could be induced to react through protection by an external coordinating borane. — JSY

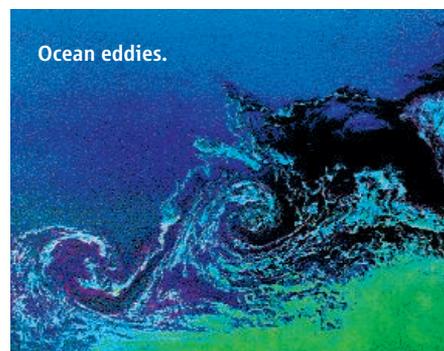
Angew. Chem. Int. Ed. **46**,
10.1002/anie.200702908 (2007).

OCEAN SCIENCE

An Emergent Role for Eddies

Much of the kinetic energy of the ocean is concentrated in the mesoscale region of its energy spectrum, which is populated by structures with

dimensions of tens to hundreds of kilometers and durations of tens to hundreds of days. There are two distinct types of mesoscale variability—linear westward-propagating Rossby waves and nonlinear eddies—but it is difficult to distinguish one from the other observationally. Satellites have proven to be the best platform for measuring the extent of these features, and based on data they yielded, the accepted view became that most of the mesoscale variability of



the oceans was due to Rossby waves. Now, however, Chelton *et al.* have used additional multi-satellite altimeter data to show that more than half of the extratropical sea surface height variability that defines these structures is actually due to eddies. The remaining variation is probably due to eddies with shorter lifetimes, methodological error, and other physical processes such as Rossby waves. Because nonlinear eddies can transport momentum, heat, and mass, they can

contribute to general circulation and ocean biology in ways that Rossby waves cannot. — HJS
Geophys. Res. Lett. **34**, L15606 (2007).

MOLECULAR BIOLOGY

Prospective Sampling

Like its chemical cousin DNA, the most common structural motif adopted by RNA is the double helix. There are many instances (transcription, pre-mRNA processing, and ribosome biogenesis) where double-stranded RNA (dsRNA) needs to be unwound and unzipped, functions performed by motor proteins known as RNA helicases. To understand more about how helicases go about their business, Cheng *et al.* have challenged the hepatitis C virus NS3 helicase with strong-versus-weak and long-versus-short barriers. They show that NS3 readily unzips a hairpin of 30 A:U base pairs but dissociates or pauses before entering the same length of more stable G:C base pairs. When faced with a three-G:C base pair zipper, NS3 ploughs right on through, yet lengthening the barrier to six G:C base pairs causes NS3 to pause, indicating that the enzyme must be sampling the RNA just ahead of where helicase-mediated unwinding takes place. The former interaction may serve to destabilize the dsRNA during the pause that precedes unwinding and thereby enhance the processivity of the enzyme. — GR

Proc. Natl. Acad. Sci. U.S.A. **104**, 13954 (2007).

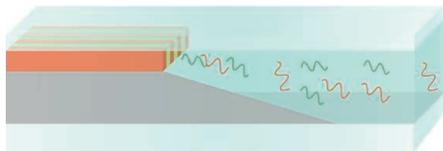
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MATERIALS SCIENCE

Solidifying into Shape

Finding materials that spontaneously form specific ordered patterns is a key for bottom-up fabrication strategies at the nanometer scale. Block copolymers, in which two or more dissimilar polymers are chemically linked, have the advantage in this respect of being thermodynamically driven toward regularly spaced patterns. One shortcoming though is that tuning the pattern often requires synthesis of a new block copolymer. Ejima *et al.* show that directional crystallization, a technique that has been used to enhance the patterning of block copolymers, can also be applied to a mixture of dissimilar homopolymers, which would normally phase-separate into large disordered regions. They combined poly(L-lactic acid) (PLLA), a crystallizable polymer, with poly(vinyl acetate) (PVAc),



one of many amorphous polymers with which PLLA is miscible. The two were dissolved at high temperature in hexamethylbenzene (HMB) and afterward transferred to a heating stage below the melting temperatures of HMB and PLLA but above the glass transition temperatures of both polymers. As the HMB crystallized along a growing front, the concentration of PLLA increased until it too formed axial crystals in the same direction (as distinct from the usual spherulitic morphology). Pitch spacings of 69 nm were

observed over large sample areas and were tunable by variation of the PVAc fraction. — MSL
Macromolecules **40**, 6445 (2007).

CHEMISTRY

A New Pair of Dice

The metal-sulfide clusters at the heart of the nitrogenase proteins pose questions for the biochemist—how are these assembled and inserted?—and for the inorganic chemist—what are the electronic properties that enable these enzymes to catalyze the reduction of dinitrogen under mild conditions? The P cluster (Fe_8S_7) and the FeMo cofactor (MoFe_7S_9) of the MoFe nitrogenase both contain a framework that can be described as two cubes joined at a vertex, which is either a hexacoordinate sulfur atom or an unidentified light atom (thought to be C, N, or O), with the central six iron atoms connected by two or three other sulfur ligands. Ohki *et al.* have synthesized a new [8Fe-7S] cluster where the incomplete cubanes are linked by a hexacoordinate sulfur and three anionic ligands. Bulky thiol substituents (R = dimesitylphenyl and triisopropylphenyl) and nonpolar solvents stabilized the dimeric $[\text{Fe}_2(\mu\text{-SR})_2]$ core of the starting material, which after reaction with elemental sulfur for 4 days provided a Fe_8S_7 cluster in 28% yield. A cyclic voltammogram indicated that the cluster may be electrochemically active, and EPR measurements supported the assignment of the oxidation states as $\text{Fe(II)}_5\text{Fe(III)}_3$. The P cluster and the FeMo cofactor are but a few synthetic steps away, at least on paper, raising the possibility that this thermodynamically stable construct might also be accessed biochemically. — GJC

J. Am. Chem. Soc. **129**, 10457 (2007).



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<< A Silent Partner

Like the vertebrate retinoid X receptors (RXRs) that it structurally and functionally resembles, the arthropod protein ultraspiracle (USP) heterodimerizes with other nuclear receptors to activate transcription of target genes. Various substances activate RXRs and have been postulated to serve as endogenous ligands, and the USP binding partner EcR (ecdysone receptor) is activated by ecdysone. Noting the similarity between the ligand-binding domain of USP in arthropods that are not Mecoptera (which includes the flies and moths) to that of the RXR, Iwema *et al.* cloned USP from the beetle *Tribolium castaneum* (TcUSP) as a representative non-Mecoptera USP. RXR ligands failed to activate a protein containing the TcUSP D/E domains (regions important for ligand binding and heterodimerization), and electrospray ionization mass spectrometric analysis indicated that TcUSP failed to bind RXR ligands *in vitro*. Analysis of the crystal structure of the TcUSP ligand-binding domain in the context of a functional TcUSP-EcR heterodimer indicated that TcUSP exhibited a stable apo structure in an inactive antagonist conformation, which did not have a conventional ligand-binding pocket. Phylogenetic analysis emphasized the evolutionary plasticity of the RXR-USP-family ligand-binding domain, suggesting that even though non-Mecoptera USP does not, RXRs do indeed bind endogenous ligands. — EMA

EMBO J. **26**, 3770 (2007).