

THIS WEEK IN Science

edited by Phil Szuromi


Unsuspected Depths

Sunspots reveal open magnetic field line regions on the Sun that are directly related to the dynamo mechanism that creates the magnetic field structure. Observations indicate that most sunspots form at low latitudes, but models based on the measured solar rotation place sunspots at high latitudes. Nandy and Choudhuri (p. 1671) have developed a dynamo model that resolves the latitudinal discrepancy by adding a deep meridional flow of material. This previously unrecognized flow could have important implications for the dynamical and chemical evolution of stars like our Sun.

Subduction Tremor

Volcanic tremor is a low-frequency, long-period, and nearly constant amplitude waveform detected by seismometers in volcanic regions; it usually is associated with the movement of fluid or magma in a narrow volcanic conduit. Using the recently deployed 600 seismometers of the high-sensitivity seismographic network (Hi-net), Obara (p. 1679; see the Perspective by Julian) has detected the characteristic waveform of volcanic tremor in southwest Japan, even though there are no volcanoes in this region. The tremors are located along the strike of the subducting Philippine Sea Plate and extend to a depth of as much as 45 kilometers. These tremors are probably associated with the movement of fluids in narrow fractures along the subduction zone and represent a new seismic phenomenon.

Suture, Knot Thyself

Shape-memory materials can undergo deformation but then recover their original shape after being heated above some critical temperature. Lendlein and Langer (p. 1673) now show that a number of shape-memory biodegradable polymers can be used as self-closing sutures. The polymer fibers were first stretched to create a deformed state. The fibers were then loosely sewn and knotted around an incision. Heating to body temperature caused the fibers to shrink and tighten and thus close the wound. The composition of these two-component polymers can be adjusted to change the transition temperature and restore stress for different applications. 

They've Got the Beat

Individual harmonic oscillators with different frequencies, whether heart pacemaker cells or members of an audience clapping, can synchronize if they are coupled strongly enough. Theory has long sug-

1661 Of Mice and Humans

Mural *et al.* (p. 1661) provide a first peek at the differences between mammalian species with their analysis of the sequence of mouse chromosome 16. Gene content and order were highly conserved when compared with blocks of sequence on six of the human chromosomes. Only 14 of the 731 predicted genes on chromosome 16 were specific to the mouse. As Copeland *et al.* describe in a Perspective, such comparisons will provide insights into evolution and gene function.

And in Brevia ...

Dinosaur tracks discovered by Day *et al.* (p. 1659) indicate that large, titanosaur sauropods were present by the Middle Jurassic, about 163 million years ago, and that they traveled in herds with other sauropods.

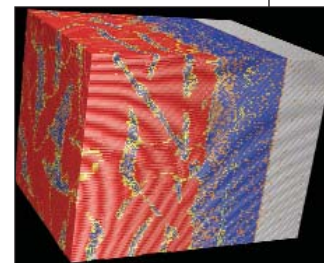
gested that a large number of oscillators should self-synchronize even with weak global couplings. Kiss *et al.* (p. 1676) studied a small set of noisy harmonic oscillators (64 electrochemical cells) and verify experimentally the key predictions of this theory, including the observation of a critical point in the coupling strength. They also show that chaotic and even anharmonic oscillators exhibit similar self-synchronization responses.

Less Is Less, But More Efficient

Sustainable agriculture depends on successful recycling and maintenance of soil quality during farming. Compared to modern conventional farming, organic farming systems make greater use of nutrient recycling and associated insect and microbial communities. Mäder *et al.* (p. 1694; see the news story by Stokstad) have compared the dynamics of conventional and organic farming over a 21-year field trial in Europe. Although the yield from the organically farmed plots was somewhat less than that from conventionally farmed plots, the organically farmed plots were considerably less demanding of fertilizer and energy input.


Shock Treatment

It has long been known that steel can be hardened by rapid cooling, which causes a diffusionless structural transition, called a martensitic transformation, that may be triggered either by temperature or by pressure changes. Experimental and theoretical studies of these transformations are complicated by the fact that they involve small displacements of many atoms. Kadau *et al.* (p. 1681) use massively parallel molecular dynamics simulations of millions of atoms to elucidate what happens during shock-induced structural phase transformations. The predicted behavior as a function of shock strength and crystallographic shock direction can be tested with ultrafast time-resolved laser-generated x-ray diffraction.



Folk Medicine Meets Nuclear Receptors

The gum resin of the guggul tree *Commiphora mukul* has been used in Ayurvedic medicine since 600 BC to treat a wide variety of ailments, including obesity and lipid disorders. Although not well known in Western medicine, an extract of this resin (guggulipid) is clinically approved and widely used in India as a cholesterol-lowering agent. Urizar *et al.* (p. 1703) show that guggulsterone, the active agent in this extract, is a potent antagonist ligand for the nuclear

hormone receptor FXR. As the primary bile acid sensor, FXR plays a central role in cholesterol metabolism; thus, this antagonist function is likely to be the molecular basis for guggulsterone's lipid lowering activity. These results raise the exciting possibility that FXR and other nuclear hormone receptors may mediate the effects of other biologically active natural products that could provide new leads for drug development. 

Actions and Consequences

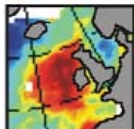
Our predictive understanding of the outside world is predominantly based on learning about the relationship between stimuli (classical or "Pavlovian" conditioning) and on learning about the consequences of our own behavior (operant conditioning). The neuronal mechanisms underlying operant conditioning are largely unknown. Brembs *et al.* (p. 1706; see the Perspective by Rankin) developed an operant conditioning paradigm in the marine invertebrate *Aplysia* and used *in vivo* and *in vitro* experiments to unravel the cellular basis of operant conditioning of feeding behavior.

Warming Trend I: Boreal Forest Greening

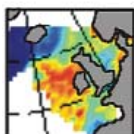
Satellite measurements have shown that the length of the growing season of high-latitude forests has been increasing over the past 20 years. This may be one of the first signs of an ecosystem response to global warming, but the observation alone does not explain which factors are responsible. Lucht *et al.* (p. 1687) employ a dynamic vegetation model and find that the main cause was the temperature increase during that period. The strength of the model is further demonstrated by its simulation of the decrease in vegetation that accompanied the cooling produced by the 1991 volcanic eruption of Mt. Pinatubo.

Warming Trend II: Oxfordshire Flowering

Fitter and Fitter (p. 1689) have analyzed the flowering dates of 385 species of British plants over 47 years and shown: (i) that climate warming is having a powerful effect in advancing plant development, especially in the 1990s; (ii) that species differ greatly in their sensitivity to this warming, with spring-flowering, insect-pollinated species being most responsive; and (iii) that because of these large differences in response, there will be substantial ecological and evolutionary consequences, including changes in competitive interactions and in the probability of interspecific hybridization. The size of this data set allows a characterization of the nature and magnitude of the response in different plant species and life forms.



1960-1975



1992-1995

Warming Trend III: North Atlantic Ecosystems

On the basis of marine plankton data gathered since 1946 in the Continuous Plankton Recorder survey, Beaugrand *et al.* (p. 1692) describe changes in the species composition of copepod biota in the North Atlantic during the past four decades. They find that southern species have migrated northwards in the eastern Atlantic along the coast of Europe, whereas northern or Arctic species have moved southwards in the western Atlantic off the coast of North America. These data are consistent with recent, anthropogenically mediated changes in climate, reflected by northern hemisphere temperature anomalies and the North Atlantic Oscillation.

Are We There Yet?

During goal-directed activity, we continually update our current status with our expectations for finally attaining the goal. Expectation normally increases over the course of the activity, and, to find the neuronal signals that underlie this increasing expectation, Shidara and Richmond (p. 1709) analyzed single neuron activity in an area of the brain called the anterior cingulate cortex. They recorded from monkeys performing a sophisticated, multistep paradigm in which reward expectancy could be manipulated and found that in a subpopulation of neurons, activity was correlated with the expectation of reward. This study provides support for the important role of the anterior cingulate cortex in the representation of reward expectancy and emotional states, as discussed by Peoples in a Perspective.