Corals in Deep Water

Tropical, shallow-water coral reefs have been the subject of intense research for many decades. The deepwater coral ecosystems, many of which occur at higher latitudes, are much less well known. Roberts et al. (p. 543) review the latest research on coldwater corals, focusing particularly on the North Atlantic, where most of the recent exploration has taken place. Like their shallow-water counterparts, deepwater coral reefs appear to harbor a high diversity of species. Much remains to be discovered about the biology of these systems, but it is already clear that they are vulnerable to threats from exploitation and climate change.

Periodic Pulsing

Pulsars are spinning neutron stars with strong magnetic fields that generate radio beams that sweep across the sky. Why do some neutron stars emit radio waves but others do not? Kramer et al. (p. 549, published online 2 February; see the Perspective by van den Heuvel) found a pulsar, B1931+24, that looked normal for about 1 week but then suddenly switched off. It remained undetectable for 1 month before switching on again. These on-off cycles repeat. All pulsars spin more slowly as they lose energy, but B1931+24 spins down 50% faster when it is switched on. This behavior implicates particle currents and winds in pulsar deceleration, and allows the sizes of the currents to be measured.

Teaching Spins to Stay

Manipulation of the spin state of quantum dots could provide a route for quantum information processing. However, it has been difficult to prepare the quantum dot in a particular state (either spin-up or spin-down), and then maintain that spin state because of internal scattering and spin-flip processes occurring within the dot. Atatüre et al. (p. 551) laser-cooled an electron spin on a quantum dot from 4 kelvin to 20 millikelvin and showed that its desired spin state could be achieved with 99.8% fidelity.

A Super Seismically Slow Silicate

The ultralow seismic velocities seen for the core-mantle boundary are normally attributed to the presence of melted mantle. The main solid phase recently identified as stable, under the temperature and pressure conditions of this region, is a magnesium-rich silicate called post-perovskite.

Mao et al. (p. 564) show through high-pressure experiments that seismic velocities in iron-rich post-perovskite, which might be produced in mantle regions near the iron core, are slower even than those of ultraslow velocity waves. Thus, a mixture of solid phases that includes iron-rich post-perovskite might explain the seismic observations without requiring the presence of a melt.

Imitating Insect Eyes

The eye of a bee contains thousands of integrated optical units that are pointed in different directions. Each of these units collects incident light from a narrow angular range and helps contribute to the eye’s wide field of view. Through a combination of micro- and nanofabrication techniques, Jeong et al. (p. 557) made a synthetic analog that closely parallels these compound eyes and shows comparable optical properties.

Closer Comet Cache

Comets are believed to be primitive dirty snowballs that come from the cold outer reaches of the solar system. However, Hsieh and Jewitt (p. 561, published online 23 March; see the Perspective by Fitzsimmons) propose that a new class of comets exists in the main asteroid belt. A survey of main-belt asteroids revealed three with cometary tails, which suggests that icy asteroids can become activated and appear as comets after collisions. As these objects likely formed in situ in a warmer environment, such main belt comets should differ in composition as well as orbit from the cold Kuiper Belt and Oort Cloud comets. Main belt comets could have contributed water to the early Earth.

Cultural Recalibration

Comparison of major events in early Mediterranean cultures in Crete, the Levant, Egypt, and elsewhere during the Bronze Age requires an accurate chronology for comparison. One critical tie point is the age of the Santorini eruption, which flung ash across the area, but this needs to be augmented with longer and better chronologies in each locality. Manning et al. (p. 565) present a large number of radiocarbon dates spanning 300 years that, along with a more firm Santorini age (see the Brevia by Friedrich et al., and the cover), shift the Aegean record about 100 years earlier. Thus, the major New Palace Crete culture was contemporaneous with one in the Levant, not with the New Kingdom period of Egypt as had been inferred.

Unreliable Mitochondrial DNA

Variability in mitochondrial (mt)DNA is often used to infer population size, history, and diversity on the assumption that mtDNA is essentially evolutionary neutral. Bazin et al. (p. 570; see the Perspective by Eyre-Walker) compared a wide range of animal species for polymorphisms in alozymes, nuclear DNA, and mtDNA. Within-species alozyme and nuclear DNA variability correlated with expected species abundance and ecological variables, whereas essentially no difference was observed between a broad range of taxa in terms of mtDNA variability. Instead, mtDNA seem to have undergone recurrent fixation of beneficial
Mutations and loss of variability at linked loci. Thus, mtDNA is far from a neutral marker; its diversity is essentially unpredictable and may not reflect population history and demography.

Mosquito Resistance
What happens to malaria parasites in their wild mosquito vector? Riehle et al. (p. 577) examined wild mosquitoes fed on the blood of naturally infected people in Mali and identified four genes that affect the insects’ ability to resist the parasite. The genes act against at least three different species of malaria parasite. One of the genes, which causes parasite melanization in the lab, probably has little effect in natural systems. The three other genes, however closely resemble pattern-recognition resistance genes found in a many plants and animals. A large proportion of wild mosquitoes remained uninfected despite being fed malaria-infected blood.

Fungi Versus Plants and Mammals
Rice blast is an economically important disease caused by the fungus Magnaporthe grisea, which enters leaves by developing specialized structures called appressoria. Veneault-Fourrey et al. (p. 580) show that during invasion, the fungus undergoes a form of programmed cell death that involves autophagy. Thus, fungal pathogens can use cell death for cellular differentiation and remodeling during host infection. Fungal virulence, the ability of opportunistic fungal pathogens to thrive in mammals, is associated with a transformation from a filamentous, pseudohyphal form that grows at 25°C into a yeast form at 37°C. Using the plant pathogen Agrobacterium tumefaciens as a tool for T-DNA insertional mutagenesis, Nemecek et al. (p. 583) identified mutants that locked the organism in the filamentous form. One mutant that could not make the yeast form also showed defects in cell-wall formation, sporulation, and expression of virulence factors. The defect lay in a gene encoding a histidine kinase, which appeared to be the global regulator for morphological switching and virulence in several species of dimorphic fungi.

Voltage-Gated Proton Channel
Voltage sensor domains comprise four transmembrane segments (S1 to S4) and are responsible for sensing changes in membrane potential and controlling gating of the pore domain (S5 and S6) in voltage-gated ion channels. Sasaki et al. (p. 589, published online 23 March) have identified a protein consisting primarily of a voltage-sensor domain (VSD) that appears to mediate voltage-gated proton currents. The proton currents exhibit pH-dependent gating and are sensitive to zinc ion concentrations, features that are characteristic of voltage-gated proton channels.

BoTox Receptor
Botulinum neurotoxin type A (BoNT/A) is one of seven neurotoxins produced by the bacterium Clostridium botulinum. BoNT/A has a long half-life within cells and is widely used in treatments of wrinkles to chronic pain. Moreover, BoNT/A can cause paralysis that persists for months. BoNT/A is known to block neurotransmission by cleaving the protein SNAP-25 in presynaptic terminals, but it is not clear how this toxin selectively recognizes and enters neurons. Dong et al. (p. 592, published online 16 March; see the Perspective by Miller) now identify a protein component of the cellular receptor for BoNT/A as a synaptic vesicle protein, SV2. BoNT/A enters neurons via recycling synaptic vesicles by binding to SV2 isoforms, and cells and animals lacking SV2 are resistant to intoxication.

Switching Spermatogenesis Off and Oogenesis On
Male and female germ cells enter meiosis at different times. Spermatogenesis results from meiosis during fetal development, whereas oogenesis results when meiosis initiates after birth. It has been thought that germ cells enter meiosis and initiate oogenesis by default, unless blocked by an uncharacterized diffusible signaling molecule produced by the testis. Bowles et al. (p. 596, published online 30 March) now show that retinoid metabolism inhibits meiosis in male embryos. In both males and females, the morphogen retinoic acid is produced in the mesonephric tubules for the initiation of meiosis. The morphogen is not degraded in the ovary, but it is specifically degraded in the testis by the p450 cytochrome enzyme CYP26B1.