Ecology Then and Now

Plants and their insect predators form a complex and evolving ecosystem (see the Perspective by Kitching). Wilf et al. (p. 1112) show that the Cretaceous-Paleogene extinction complicated plant-insect coevolution for perhaps several million years. In one location after the extinction, a limited species of leaves reveal diverse insect predation. In another, many species of leaves show limited types of predation. Thus, in some locations, plants seemed to have evolved without much insect predation, while in others, insects evolved despite limited plant diversity. In contrast, Novotny et al. (p. 1115) compared present-day insect host specificity and diversity on phylogenetically comparable sets of plants in tropical and temperate forests. Coexistence of numerous herbivore species in tropical forests did not seem to reflect narrower niches; instead, herbivore species richness appeared to be driven by plant diversity.

A Sandwich with Extra Palladium

In the 50 years since Wilkinson’s characterized ferrocene, chemists have manipulated nearly every metal in the periodic table into a sandwich between planar cyclic aromatic hydrocarbons. However, despite the available space between the flanking rings, the central compounds have almost never contained more than one metal center. Murahashi et al. (p. 1104) prepared and characterized a compound with three palladium atoms sandwiched between tropilium rings, and another with five palladium atoms sandwiched between naphthacenes. The structures present an interesting boundary case between discrete molecules and layered solids.

Supersolid Flow in Grain Boundaries?

When two reservoirs of a liquid are brought together, their levels will equilibrate to a common level. Recent experiments have found evidence of “supersolid” behavior in solid 4He, where superfluid-like mass flow through the solid was observed. How a solid can flow like a superfluid has been controversial. Sasaki et al. (p. 1098, published online 3 August; see the 4 August news story by Cho) reexamined mass flow between two reservoirs of superfluid 4He separated by a barrier of solid helium and propose a model in which superflow along grain boundaries in the solid accounts for the observed mass transport.

Freshen This

The Nordic and Atlantic Subpolar Oceans of the Northern Hemisphere became less saline during the past half-century, and Peterson et al. (p. 1061) address the problem of the origin of the necessary freshwater inputs. They examined how precipitation onto the ocean, river discharge, glacial melt, and sea ice melt have changed recently in comparison to a baseline from 1936 to 1955. This understanding is particularly important in light of projections of a continued increase in precipitation in high northern latitudes and the critical role that this region is thought to play in regulating ocean circulation and global climate.

Neuronal Stimulation and Recording

It would be useful to interrogate or modify the electrophysiology of neurons in detail. One promising approach is to use small field-effect transistors (FETs). Patolsky et al. (p. 1100) assembled arrays of p- and n-type silicon nanowires and then used polylysine patterning to direct the growth of rat cortical neurons on the wires so that the dendrites and axons of a single neuron could be stimulated or interrogated at up to 50 locations along one axon in physiological media. The action potentials induced with the usual glass microelectrode or with the nanowire transistors were comparable, and the nanowire junctions could be used to inhibit signals as well as measure propagation speeds.

Migrating Moons

Pluto’s two recently discovered moons travel in orbits that appear to be influenced by the largest satellite, Charon. The two moons’ orbits are circular and coplanar with that of Charon, which suggests that they formed in a common impact as opposed to being captured independently. However, all three moons lie at large distances from Pluto, so if they were formed together in a collision they must have migrated outward. Ward and Canup (p. 1107, published online 6 July; see the Perspective by Lissauer) propose that the two moons were created in the same impact that produced Charon. To avoid the disruption of the system as it expanded, the two small moons remained in corotation resonances with Charon. Corotation type resonances, similar to those that constrain Neptune’s ring arcs, would not have altered the eccentricities of the satellites after capture.

Moderate Methane Changes

The atmospheric concentration of methane, a powerful greenhouse gas that is also a useful tracer of global carbon cycling, varied dramatically between cold and warm periods of Earth history during the past 800,000 years. The causes of these variations are still unclear. Schaaf et al. (p. 1109) analyzed West Greenland ice to develop a record of the stable isotopic composition of the carbon in atmospheric methane at the end of the last deglaciation, when the concentration of methane in the
atmosphere increased from 500 to 750 parts per billion in less than 200 years. The carbon-isotopic composition of methane changed remarkably little, implying that the methane was being released from tropical wetlands rather than ocean clathrates.

Linking LTP with Learning and Memory
The phenomenon of synaptic long-term potentiation (LTP) was discovered more than 30 years ago in the hippocampus. Although it is commonly thought that hippocampal LTP is induced by learning, there has not been a direct demonstration (see the Perspective by Bliss et al.). Whitlock et al. (p. 1093) recorded field potentials from multiple sites in hippocampal area CA1 before and after single-trial inhibitory avoidance learning. Field potentials increased on a subset of the electrodes, and these could be specifically related to the learning event. Pastalkova et al. (p. 1141) reversed hippocampal LTP in freely moving animals using a cell-permeable inhibitor of a protein kinase. Reversal was accompanied by a complete disruption of previously acquired long-term memory in a place avoidance task, even when the kinase inhibitor was infused only during the consolidation interval. This result suggests that LTP was necessary for storing spatial information.

Dealing with DNA Damage
Cells need to be able to respond to DNA damage to restrict its consequences for the organism as a whole. Dornan et al. (p. 1122) found a new target for the protein kinase ATM (which when mutated causes ataxia telangiectasia, a disease that renders patients sensitive to ionizing radiation and an increased risk of cancer). ATM is activated in response to DNA damage and phosphorylates COP1, an E3 ubiquitin ligase that controls ubiquitination and degradation of the key tumor suppressor protein p53. This phosphorylation appears to cause COP1 to turn on itself, mediating its own autoubiquitination and consequent degradation, leading to the accumulation of p53. In tissue cultures, this phosphorylation event appears to be necessary for p53-dependent tumor suppressor activity in response to DNA damaging agents.

Getting to Grips with Gut Flora
All mammals rely on a factory of symbiotic microorganisms living in the gut to help process nutrients into usable forms, but if these bacteria escape containment, they can trigger damaging inflammatory responses. Mammals use several adaptive and innate systems to keep the gut flora in check, including microbicidal peptide defensins, lysozymes, and lectins. Cash et al. (p. 1126; see the Perspective by Strober) have discovered that the expression of a carbohydrate-binding protein—a lectin—is induced by the intestinal microbial population from Paneth cells in the crypts. This lectin is among the most highly expressed proteins in the small intestine, recognizes peptidoglycan, and is directly bactericidal. Indeed sufferers of inflammatory bowel disease tend to express elevated levels of C-type lectins.

Fish Eyes
Cell movements and molecular factors direct organ development. Rembold et al. (p. 1130) used high-resolution in vivo imaging to reconstruct eye morphogenesis at the single-cell level in wild-type, mutant, and mosaic fish. Hundreds of cells representing retinal progenitor cells and presumptive forebrain cells are tracked simultaneously. The analyses indicate that retinal progenitor cells actively migrate during optic vesicle evagination and that the optic vesicle forms from individual cell movements, not tissue movements.

Diabetes—An Unfolding Story
Obesity triggers stress in the endoplasmic reticulum (ER), a network of intracellular membranes involved in protein folding and trafficking. That ER stress in turn disrupts insulin signaling. Ozcan et al. (p. 1137) investigated whether a class of small-molecule drugs that normalize ER function, called “chemical chaperones,” might have therapeutic benefits in type 2 diabetes. These drugs were found to correct hyperglycemia and restore insulin sensitivity in genetically obese and diabetic mice, suggesting that they merit further study as a potential therapy for human diabetes.