ECOLOGY

Jet Transport

Deposits of windblown dust originating from the Sahara may have been responsible for the prehistoric condition of the Everglades, the vast area of wetlands at the southern end of the Florida peninsula. Our understanding of the history of the Everglades ecosystem and of the ecological conditions that produced and sustained it has been hampered by the extensive human transformation of the landscape, particularly in the past century. An analysis of sediments deposited over the past 4600 years provides a record of the vegetation and soil nutrient patterns and shifts in hydrology, revealing some of the processes that have hitherto remained obscure. Glaser et al. show that dust deposition mediated by frequent tropical storms was an important source of nutrients for the Everglades until about 2800 years ago, when a climatic shift in the tropical Atlantic and Gulf of Mexico led to weather patterns that sharply decreased the level of dust inputs and led to a drier climate and a gradual loss of soil phosphorus, carbon, and nitrogen. The vegetation concomitantly changed from a slough assemblage of aquatic and semiaquatic plants to communities of sawgrass and pine, which began to dominate as the water table fell and the nutrient levels decreased. — AMS


BIOCHEMISTRY

Dual Use

Protein phosphatase 2A (PP2A) is a serine/threonine phosphatase involved in many essential cellular processes. The core enzyme is a heterotrimer in which a catalytic subunit (PP2Ac) associates with a scaffold subunit A and with one of a diverse set of regulatory subunits B; the catalytic subunit must be activated for proper holoenzyme formation. Guo et al. have determined the structure of PP2Ac in complex with a fusion protein comprising the PP2A phosphatase activator protein (PTPA) and a mini-A subunit, and with ATPγS bound. The structure shows that both PTPA and PP2Ac interact with ATPγS and that the phosphate of ATP binds to catalytic metal ions. The authors suggest that the ATP-binding pocket is created upon complex formation and that this results in ATP hydrolysis at the PP2Ac active site, which is also where the removal of phosphates from serine/threonine occurs. Biochemical experiments suggest that ATP facilitates binding of the appropriate metal ions to PP2A and that this reduces nonspecific phosphatase removal. Coordinated regulation of both PP2Ac activity and holoenzyme formation would allow for a tight regulation of PP2A function. — VV


MATERIALS SCIENCE

In Rare Titania Form

One route for synthesizing mesoporous and microporous inorganic materials is to use an organic material as a template, such as a surfactant or a block copolymer, but the resulting pore network can be disordered. Hall et al. show that the inherent microporosity of a metal-organic framework (MOF) compound can be used to template an ordered microporous form of titanium oxide. They used the MOF HKUST-1, in which copper ions linked together by benzene-1,3,5-tricarboxylate ligands create a network of 1-nm pores. The material was impregnated with a metal oxide precursor, titanium(IV) isopropanoxide, and then underwent a hydrothermal treatment at 200°C for 20 hours in a water-ethanol solvent. This product was treated with acid and then hydrogen peroxide. These procedures removed almost all of the MOF framework, although some copper and residual carbon were retained. Transmission electron microscopy and x-ray diffraction studies showed that the morphology of the HKUST-1 template and the pore size of 1 nm were retained in the metal oxide. These studies also revealed that the phase of titania is brookite, which probably formed instead of the more common rutile or anatase phases because of the presence of copper ions. However, nitrogen adsorption-desorption studies revealed that disordered mesopores are present, which probably resulted from incomplete pore filling by the precursor. — PDS


BEHAVIOR

Genetic Conformity

Fish who swim in schools find that doing so brings benefits and costs. On the positive side of the ledger, there is greater safety from predators in numbers, it’s easier to find a mate, and swimming efficiency is enhanced; drawbacks include being vulnerable to fish harvesting. Comparing two populations of threespine sticklebacks—strongly schooling marine sticklebacks from Hokkaido, Japan, and benthic sticklebacks from Paxton Lake in British Columbia (a population that displays much weaker schooling inclination)—Greenwood et al. have identified two genomic regions that contribute to distinct dimensions of sociality. First, there is the tendency to swim with others, quantified on the basis of time spent in school, latency to enter school, and number of episodes. Second, individuals are constrained when schooling to swim in parallel to their neighbors, which was measured as relative orientation angle. Comparing the populations revealed that marine fish adopt parallel orientations more than the benthic fish. Prior work has shown that the sensory system for body...
position relies on the lateral line, a peripheral mechanoreceptive system, and the authors established a genetic link between schooling position and lateral line variation. — BAP


ENVIRONMENTAL SCIENCE

Mercury Biomagnification

In aquatic ecosystems, mercury is converted to methylmercury, which can be accumulated in top predators at levels millions of times higher than in surface waters. This biomagnification can result in toxic concentrations in fish and fish-eating species. However, mercury concentrations in fish and invertebrates differ widely between ecosystems, and it remains unclear whether biomagnification is only affected by food web processes such as growth rate and species diversity or also by physicochemical variables such as water pH, temperature, and nutrient concentrations. Lavoie et al. have compiled data from 69 studies of marine and freshwater ecosystems around the globe to determine the total mercury and methylmercury trophic magnification slopes, which are key indicators of the biomagnifying potential in food webs. The results show biomagnification to be highly variable among the reviewed sites. It is positively related to latitude and highest in cold, low-productivity ecosystems. A combination of variables related to temperature is likely to be responsible for the latitude effect, but the mechanism remains unclear. — JFU


PHYSICS

A Superradiant Amplifier

The usual notion of laser operation involves populating an excited state of a gain medium so that there are more atoms in the excited state than there are in the ground state. This population inversion can then be stimulated to emit many photons coherently with the same wavelength. The spontaneous emission of photons from atoms is a common occurrence, but the conditions for lasing cannot always be met. Six decades ago, it was shown theoretically that an ensemble of spontaneously emitting atoms could, under the right conditions, behave collectively and emit in unison, thereby giving rise to superradiant emission. In this scenario, population inversion is not necessary. Svidzinsky et al. show that a driving field of infrared light illuminating the superradiant ensemble can result in the amplified emission of coherent light but at much higher frequencies. If experimentally realized, their proposed mechanism could provide a route for the generation of coherent radiation in the UV or even x-ray range of the electromagnetic spectrum. — ISO


CLIMATE SCIENCE

Our Rain

More intense precipitation events are expected to occur as climate warms. Warmer air holds more water vapor, relative humidity should not change as air temperatures increase, and precipitation intensity depends mostly on the availability of moisture in the atmosphere. Zhang et al. use updated observational data in a multimodel ensemble analysis of global climate model simulations available from the Coupled Model Intercomparison Project Phase 5 to quantify the human influence on extreme precipitation. They find that the model response to anthropogenic effects is consistent with the changes in extreme precipitation observed over land in the Northern Hemisphere and that the observed change cannot be explained by either natural internal variability or the response to natural external forcing. They estimate that the amount of rainfall over both 1- and 5-day intervals increased by between 5.2 and 5.9% between 1951 and 2005. This means that the single-day precipitation of a size expected to recur once every 20 years on average in the early 1950s has become an event that recurs every 15 years in the early 2000s and that the increased frequency is attributable to human influence. — HJS