In This Issue

Reconstructing pesticide use from lake sediments

Pesticides and their derivatives can persist in the environment for decades, but the dynamics of their movement from the soil to bodies of water remain unclear. Pierre Sabatier et al. (pp. 15647–15652) reconstructed the chronology of pesticide use and runoff over a century in vineyards in eastern France by using sediment cores from Lake Saint André, located in the vineyard watershed in the French Alps. The authors found a temporal correlation between the appearance of pesticides—including metabolites of the herbicides glyphosate and atrazine; insecticides, including DDT and its metabolites; and fungicides—in the lake sediment record and their historical patterns of use in the upslope vineyards. Analysis of changes in the rate of sediment influx into the lake between 1900 and 2011 suggested a link between soil erosion and patterns of herbicide treatment; for example, metabolites of glyphosate, widely used to curb grass growth between vine rows since 1990, were detected in a sediment sample representing the past 20 years. Further, the authors suggest, herbicide-induced erosion may have mobilized DDT and its metabolites—banned in 1972 but lingering in the vineyard soil—into the lake. According to the authors, the findings underscore the salience of pesticide mobility to toxicological risk assessment in agriculture, particularly under changing environmental conditions. — P.N.

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Lake Saint André in the French Alps and its vineyard watershed.

High-resolution sedimentary lipid biomarker analysis

Membrane lipids of some marine microorganisms are preserved in oceanic sediments and can provide a proxy for sea surface temperature, yet analysis of lipid biomarkers has previously required centimeter-scale sediment samples and extensive chemical sample preparation, limiting the temporal resolution of paleoclimate reconstructions. Lars Wörmer et al. (pp. 15669–15674) developed a laser-based scanning method to obtain lipid biomarker measurements directly from sediment core surfaces, with minimal sample preparation, at a resolution sufficient to ascertain lipid biomarker ratios at subannual to decadal scales. The method employs laser desorption ionization to analyze tetraether lipids produced by archaea and preserved in sediment cores. Subsequent high-resolution mass spectrometry determines the ratio of two major lipids, caldarchaeol to crenarchaeol, a proxy for the temperature in which the archaea lived. Analysis of a sediment core from the eastern Mediterranean Sea produced temperature reconstruction data suggesting that 200-year solar cycles may influence both sea surface temperature and the ecology of marine archaeal communities. The results suggest that high-resolution sediment scanning techniques may help evaluate lipid biomarkers and inorganic components of sedimentary records at a subannual scale, according to the authors. — P.G.

Resting memory processing and future learning

Offline memory processing, such as spontaneous reactivation of memories during rest, can strengthen memories, although the effect of offline processing on future encoding of new memories is unknown. After presenting 35 participants with a face–object association learning task, Margaret Schlichting and Alison Preston (pp. 15845–15850) monitored the participants' neural activity with fMRI during a rest period and again during learning of related and unrelated object–object associations. The authors later tested participants' recall of the second learning session and inferences about the relationships between the first and second learning tasks. Spontaneous face processing-related brain activity during rest was correlated with improved learning of related associations. Further, the degree of functional coupling between the hippocampus and face-sensitive neocortex during rest was predictive of neural engagement during the second learning task. The authors suggest that strong encoding of initial memory may lead to strong memory reactivation during rest, improving future learning outcomes. Resting reactivation of memories may facilitate new learning and inference by providing a foundation of knowledge to which new memories can be linked, according to the authors. — P.G.

Modeling sand ripple formation

Blowing winds create patterned waves of sand called aeolian sand ripples, but it is unclear how the movements of sand particles create these forms and determine their size. Orencio Durán et al. (pp. 15665–15668) mathematically modeled the motion of different sand particle sizes under varying wind velocities to reproduce the formation of sand ripples and accurately predict the wavelengths observed between ripples in the field. Contrary to previous models that predict that ripple wavelength is independent of wind velocity, the current model confirmed that ripple wavelength and velocity are proportional to wind velocity. The model suggests that during ripple formation, wind picks up sand grains from troughs between ripple crests and deposits grains at a distance proportional to the wind velocity, creating the next crest. As each particle lands, the force propels other sand grains into the air that are carried along by the wind, perpetuating ripple formation and causing the ripples to migrate over time in the downwind direction. According to the authors, the model may be used to remotely measure sand movement in locations such as Mars. — J.P.J.

Image courtesy of Rosino on Flickr.

Sand ripples on a desert dune.

Detecting ion channel activity in living cells

Electrically excitable cells such as neurons can fire in a wide variety of patterns, a consequence of the complex collection of ion channels present in cells that allows electrical signals to pass through the cell membrane. Although numerous methods have been developed to measure cellular electrical signals, relatively few tools exist to determine which types of ion channels give rise to different signals within complex neuronal circuits. With an investigation of exogenous probes that detect electrical signaling, Drew Tilley et al. (pp. E4789–E4796) demonstrate that chemoselective compounds derived from a tarantula venom peptide can selectively bind to potassium channels and report the activity of voltage-gated ion channels in living cells. The probes, the authors report, use state-selective binding to optically monitor when ion channels are activated during electrical signaling, functioning at probe concentrations that do not significantly impair cellular function. According to the authors, future probes based on this prototype might help clarify when specific ion channels contribute to electrical signaling and potentially point to ion channel targets for drug therapies. — T.J.