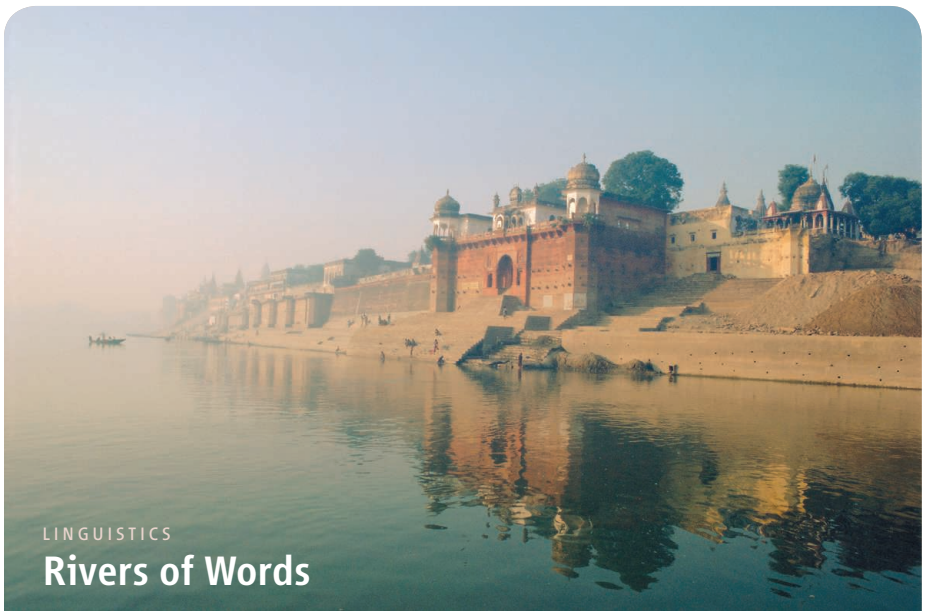


LINGUISTICS

Rivers of Words

The distribution of the ~7000 remaining linguistic groups around the globe is highly heterogeneous, with high linguistic diversity in Africa (2562 living languages) and Asia and the Pacific (2762), and less diversity in Europe (396) and the Americas (1132). As with species distribution, evidence—for example, latitudinal gradients in the density of some human languages and a correlation between landscape elevation and language density—suggests that the environment plays an important role in language distributions.

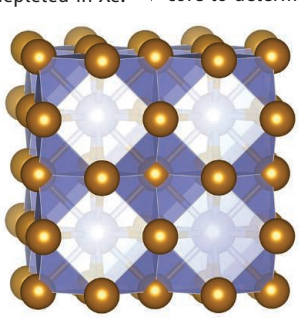
Using a variety of publicly available data sets, Axelsen and Manrubia compare 14 environmental variables, including human population density, against linguistic diversity both globally and for several continental regions (the Americas, Europe, Africa, and the Asia Pacific region). Statistical analysis of partial correlations between the 14 different factors reveals specific local dependencies in individual regions. For example, low linguistic diversity in the Americas is most correlated with population density and linked to the effects of European colonization. Globally, rivers and landscape roughness (altitude) are the most important factors underlying high linguistic diversity. Landscape roughness may promote linguistic isolation and diversification, whereas the transportation function that rivers provide may have brought disparate language groups together, seeding the formation of new ones. — GR

Proc. R. Soc. London Ser. B 10.1098/rspb.2013.3029 (2014).

GEOCHEMISTRY

Expelled Xe

Based on the distribution of other noble gases, Earth's atmosphere is apparently depleted in Xe. Although some may have been lost to space, Earth's interior—the original source of atmospheric gases—could also act as a reservoir by preferentially holding onto Xe as the planet formed and differentiated. Because of the size of the mantle, it would be an ideal candidate; however, it is unclear whether Xe reacts with the major Si-rich phases of the mantle at the corresponding pressures and temperatures. Zhu *et al.* performed total energy calculations at the extreme temperature and pressure conditions of Earth's inner core to determine that Xe reacts with Fe and Ni, the two dominant constituents of the solid inner core. Crystal structure predictions found several stable phases of Xe-Fe/Ni alloys, including the stable phases of $XeFe_3$ and $XeNi_3$, suggesting that the inner core may be Earth's missing reservoir of Xe. — NW



Nat. Chem. 10.1038/NCHEM.1925 (2014).

MATERIALS SCIENCE

Safe Sopping

Cleaning up oil or an industrial solvent after a spill is complicated by the danger that the combustible liquid might catch fire. Ruan *et al.* sought to minimize this risk by taking advantage of the flame-retardant properties of melamine. By sequentially immersing a commercial melamine-formaldehyde sponge in solutions of dopamine and then fluoroalkyl thiols, they rendered the porous material superhydrophobic. A series of tests showcased the sorption properties of the modified sponge: efficient uptake (on the order of 100 times its weight) of common solvents as well as crude oil, followed by recovery through mechanical squeezing. The material proved resilient to cycling 100 times, as well as an hour's worth of heating to 200°C or cooling by liquid nitrogen. In a comparison with a polypropylene-based sorbent, it also showed substantially greater resistance to combustion. The authors suggest that the simplicity of the synthetic protocol bodes well for possible scale-up manufacturing. — JSY

Angew. Chem. Int. Ed. **53**, 10.1002/anie.201400775 (2014).

BIOMATERIALS

Slime Fibers

When attacked, hagfish will release protein threads and mucin vesicles, which interact with seawater to form copious quantities of slime. Before release, the threads exist as coiled skeins that occupy almost the entire volume of specialized gland thread cells. The threads unravel in a fraction of a second from a 150-μm-long ellipsoid bundle to a thread that is 100 times longer, which clearly requires sophisticated ordering within the cell. As the threads also have comparable mechanical properties to those of spider silk, there is interest in understanding the organization and morphology of the coiled thread in both mature and immature gland thread cells, in order to design synthetic reactors. Using electron microscopy, Winegard *et al.* were able to identify changes in thread length, diameter, and morphology as the cells matured. Beyond this, they were able to see changes in the cell shape as it shifted from being rounded after differentiation to becoming spindle-shaped, with a more conical profile and flared base. This suggests that the cell nucleus acts as a template over which the staggered thread loops form. Using a focused ion beam within a scanning electron microscope, the three-dimensional structure of the loops was determined, including the ways that adjacent

layers overlay and the cabled appearance of the skein where the threads run circumferentially along the outer surface. — MSL

Nat. Comm. 10.1038/ncomms4534 (2014).

GENETICS

Blood and Brains

Epigenetic changes, such as gene methylation, can be detected directly by examining the status of DNA within specific tissues. However, it is desirable to identify epigenetic changes from afar, especially in tissues that may be hard to survey, such as the brain. Working with a mouse model of Cushing's disease, characterized by changes in methylation as a response to exposure to glucocorticoids, Ewald *et al*. found that methylation and expression of the *Fkpb5* gene within the hippocampus correlated with its degree of methylation in the blood. Although limited by the examination of only a single gene, the observed correlation highlights that for some diseases, it may be possible to use blood monitoring to infer epigenetic changes in the brain. — LMZ

Psychoneuroendocrinology **44**, 112 (2014).

CELL BIOLOGY

Sleep Circuit

The neurotransmitter molecule γ-aminobutyric acid (GABA) promotes sleep in mammals and flies, but the molecular details of this regulation have not been clear. Chen *et al*. provide new

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insight into this complex pathway, finding that GABA transaminase (GABAT), a mitochondrial enzyme that breaks down GABA, controls GABA amounts to affect sleep in *Drosophila*. Sleep is controlled by the protein sleepless (SSS), which is expressed in neurons of the fly brain. Its absence in mutant flies increases neural activity and decreases sleep. Mutant flies lacking SSS expressed more GABAT in the brain. Consequently, GABA amounts decreased by 30% in the brain, and compared to control flies, mutant flies slept less. Disrupting GABAT expression increased GABA amounts and boosted total daily sleep. Furthermore, reducing GABAT in mutant flies lacking SSS restored sleep. Flies expressing mutant GABAT showed an increase in overall daily sleep, and the time it took flies to fall asleep was reduced. Moreover, treatment of adult flies lacking SSS with ethanolamine O-sulfate, an inhibitor of GABAT, rescued sleep. These results suggest that SSS promotes sleep and that its absence increases neuron excitability, which may demand more energy. This could alter cell metabolism in neighboring glia, including changes in GABAT activity in the mitochondria. Changes in GABAT activity have been implicated in epilepsy (characterized by increased neural activity) and other neuropsychiatric disorders. The connection of GABAT and cell metabolism to sleep control may explain sleep problems associated with these conditions. — LC

Mol. Psychiatry 10.1038/mp.2014.11 (2014).

BIOPHYSICS

AFM Uncompromised

Atomic force microscopy (AFM) is a powerful tool used both for subnanometer imaging and for mechanical probing of molecules. The key measurement in AFM is the deflection of a cantilever, which depends on the force it experiences. AFM is used in single-molecule force spectroscopy to monitor the folding and unfolding of biomolecules. This application requires sensitivity to very small changes in force on short time scales, but also requires long-term force stability. Current AFMs are optimized either for short-term force precision (achieved by using shorter, stiffer cantilevers to reduce hydronamic drag) or for long-term force stability (better performance comes from longer, softer cantilevers). Bull *et al*. modified a short cantilever with a focused ion beam to achieve excellent short-term precision and long-term stability. AFM cantilevers are typically gold-coated to improve signal intensity, but the gold reduces stability. Removal of the gold except for a protected patch at the end of the cantilever maintained high signal without compromising stability. A protein unfolding assay highlighted the short-term precision, whereas stretching a surface-anchored protein showed sub-pN performance over a force bandwidth of 0.01 to 1000 Hz. Monitoring abrupt unfolding of a protein showed that the cantilever had a temporal response time of about 70 μs. These responsive yet stable cantilevers should benefit diverse AFM studies. — VV

ACS Nano. 10.1021/nn5010588 (2014).

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