IN THIS ISSUE

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Fairydale, Bethulie, in South Africa's Karoo Basin.

EVOLUTION

End-Permian extinction patterns in South Africa

The greatest mass extinction on Earth occurred at the end of the Permian Period, approximately 252 million years ago. However, there are few quantitative investigations of the extinction's impact on land animals. Pia Viglietti et al. analyzed 588 fossil land vertebrate specimens from the Karoo Basin, South Africa. The fossils spanned approximately 4 million years, encompassing the time of the end-Permian extinction. The authors categorized species occurrences into 13 stratigraphic bins, each representing an average time interval of 300,000 years. High extinction rates initially co-occurred with low origination rates, leading to overall ecosystem instability and rapid turnover of short-lived species. High extinction rates continued for approximately 1 million years, up to the extinction peak near the boundary between the Permian and Triassic Periods. The long duration of terrestrial extinction contrasts with the shorter extinction event recorded in ocean ecosystems. While overall species richness remained low, the ancient mammal relative *Lystrosaurus* was abundant and experienced population peaks both before and after the identified acme of the end-Permian extinction. The findings suggest that the success of *Lystrosaurus* was not fostered by ecological expansion following the extinction of other species, as hypothesized previously, but rather via advantageous environmental changes resulting from climate fluctuations, according to the authors. — M.S.

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NEUROSCIENCE

Antidepressant actions of psilocybin

Humans experience depression when genetic predisposition and environmental factors combine to produce anhedonia, the inability to feel pleasure from joyful activities. Although clinical studies suggest that psychedelic substances such as psilocybin can alleviate anhedonia, the consciousness-altering effects of such drugs are thought to be inseparable from their neuropsychiatric benefits. Natalie Hesselgrave et al. report that a single injection of psilocybin reverses two behavioral indicators of anhedonia in mice and boosts excitatory synapse activity in the mouse hippocampus, similar to traditional antidepressants. In addition, the authors found that, when pretreated with ketanserin, which mitigates the hallucinatory effects of psychedelic substances by blocking the activation of the serotonin 2A receptor, mice experience the antidepressant benefits of psilocybin despite reductions in brain and behavioral activities associated with psychedelic drug action in mice. According to the authors, animal models can be used to study the antidepressant actions of psilocybin, and the drug's consciousness-altering effects can be minimized without affecting its psychiatric benefits. — T.J.

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APPLIED MATHEMATICS

Analyzing the Lippmann method with a spectral recovery algorithm

In 1908, Gabriel Lippmann won the Nobel Prize in Physics for using interference patterns to capture and reproduce colors photographically. Despite laying the groundwork for future technologies such as holography and interferometric imaging, the Lippmann method has been overshadowed by simpler approaches that led to modern color photography. Gilles Baechler et al. present an analysis of the Lippmann

method that reveals previously unreported distortions between the incoming spectra and those reproduced by a Lippmann plate. To better understand the inconsistencies, the authors derived a mathematical description of the Lippmann process, examined how components such as reflective media, emulsion thicknesses, and development strategies affect spectral reproduction, and demonstrated these effects using electron microscopy and X-ray tomography. The authors describe an algorithm for recovering the original exposing spectra, challenging misconceptions about the invertibility of the Lippmann method, and demonstrate the algorithm's accuracy using self-made Lippmann plates. The study might renew interest in the Lippmann method and inspire new imaging technologies, according to the authors. — T.J.

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SOCIAL SCIENCES

How BMI changes across lifespan and generations

Recent decades have witnessed a rapid rise in obesity among children and adolescents. As a step toward estimating the magnitude of the future disease burden, Yang Claire Yang et al. analyzed changes in body mass index (BMI) during the aging process for various socio-demographic groups. The authors combined data from four national longitudinal surveys of 64,999 respondents ranging in age from 11 to 107 years. The participants were grouped into 17 distinct five-year birth cohorts spanning from before 1905 to 1984. Each successive cohort had a higher average BMI and a steeper rise in BMI with age, compared with the prior cohort. Both racial and educational disparities

Hilltop settlement in drylands, Morocco.

SUSTAINABILITY SCIENCE

Anthropogenic transformation of terrestrial nature

Previous studies suggest that destructive anthropogenic reshaping of terrestrial ecosystems has mostly occurred since the industrial era began. However, it remains unclear whether humans have been significantly altering nature for millennia. Erle Ellis et al. compared global maps of human populations and land use from 10,000 BCE to 2017 CE with maps of current high-biodiversity areas. As early as 12,000 years ago, almost 75% of Earth's terrestrial biosphere was inhabited by human societies. Hunter-gatherer societies and early agricultural societies were among the first to transform wildlands into human biomes. By 2017 CE, anthropogenic land use had reshaped more than 80% of Earth's terrestrial biosphere. Indigenous land, as well as protected, natural, and wild areas, exhibited long histories of anthropogenic use. Historical land reconstructions demonstrated that wildlands covered only 27.5% of Earth's land in 10,000 BCE, which contrasts with prior reconstructions showing that wildlands covered 82% of Earth's land in 6,000 BCE. Most contemporary biodiversity losses were not caused by human use of previously uninhabited ecosystems, but rather by appropriation, colonization, and long-term use of land inhabited by prior societies. The findings suggest that restoring indigenous peoples and local communities to positions of environmental stewardship may be key to conserving biodiversity, according to the authors. — M.S.

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in BMI were larger for more recent cohorts than for previous cohorts, emerged early in life, and were more substantial for women than for men. According to the authors, the findings may inform strategies to prevent rapid weight gain during the critical window of adolescence and young adulthood, reduce racial and education-based disparities in obesity, and improve health outcomes at all ages. — J.W.

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Wind shapes genetic diversity patterns in trees. Image credit: Pixabay/ dimitrisvetsikas1969.

ECOLOGY

How wind shapes large-scale genetic patterns in trees

Wind plays a critical role in plant ecology and evolution by dispersing pollen and seeds. However, how wind currents affect landscape genetic patterns at large spatial scales is unclear. Matthew Kling and David Ackerly combined models with genetic data from 72 publications covering 97 tree and shrub species, 120 datasets, and 1,940 populations worldwide. The authors found that wind patterns are strongly directional and geographically variable, in contrast to the assumptions of many classical models. Wind shapes three different facets of landscape genetics: genetic differentiation, gene flow, and genetic diversity. Populations linked by stronger winds share more genetic similarities than populations connected by weaker winds. Additionally, populations linked by directionally imbalanced winds show asymmetric movement of genetic material. Further, downwind populations tend to exhibit high genetic diversity. According to the authors, the findings could help uncover the vulnerability of forests and biodiversity to ongoing habitat fragmentation and climate change. — J.W.

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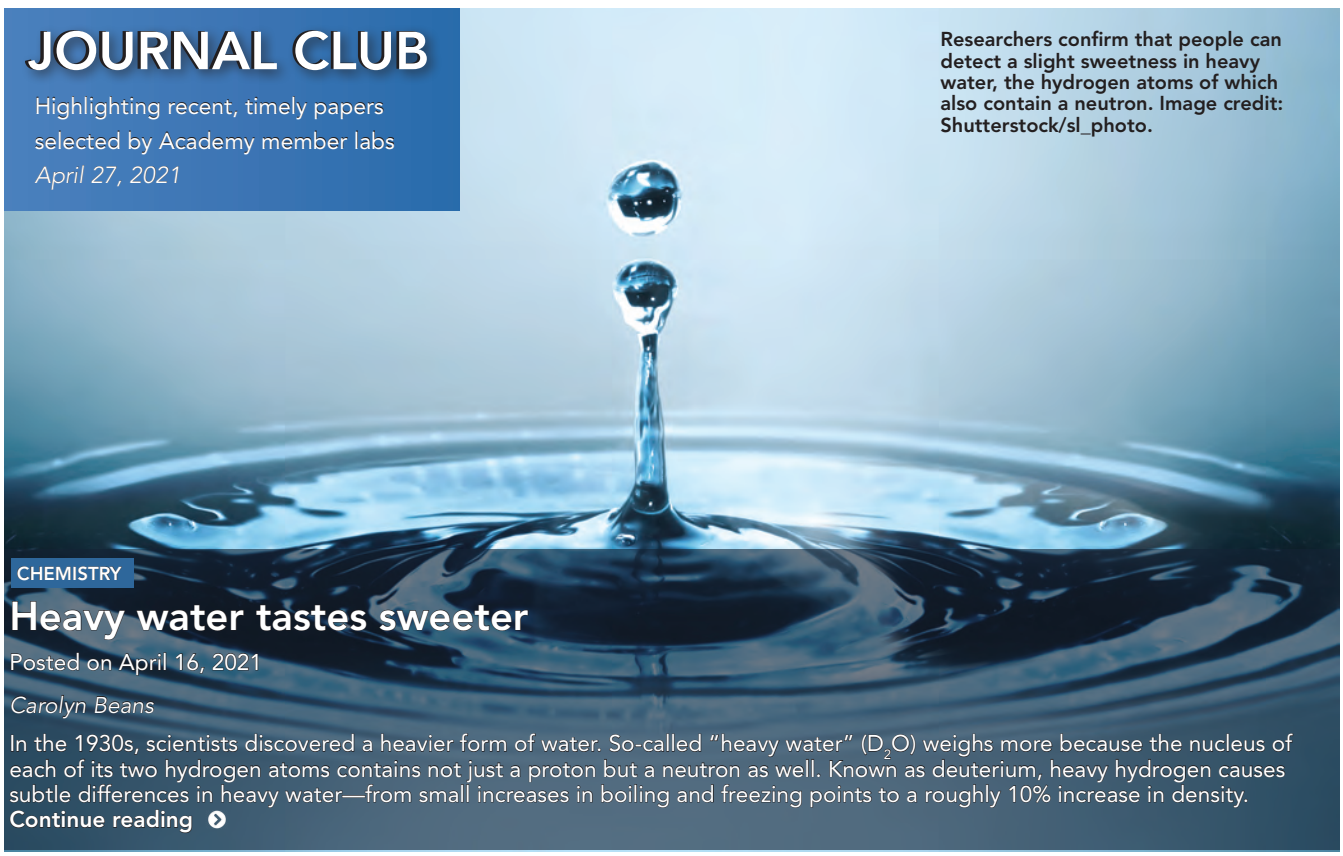

Researchers confirm that people can detect a slight sweetness in heavy water, the hydrogen atoms of which also contain a neutron. Image credit: Shutterstock/sl_photo.

CHEMISTRY

Heavy water tastes sweeter

Posted on April 16, 2021

Carolyn Beans

In the 1930s, scientists discovered a heavier form of water. So-called "heavy water" (D_2O) weighs more because the nucleus of each of its two hydrogen atoms contains not just a proton but a neutron as well. Known as deuterium, heavy hydrogen causes subtle differences in heavy water—from small increases in boiling and freezing points to a roughly 10% increase in density.

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