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Cause of end-Cretaceous dinosaur extinction

Nonavian dinosaurs went extinct during the end-Cretaceous mass extinction, 66 million years ago, which coincided with both the Chicxulub asteroid impact and heightened volcanic activity in the Deccan Traps. The relative contribution of the two environmental perturbations to the mass extinction is the subject of debate. Alfio Alessandro Chiarenza, Alexander Farnsworth, et al. (pp. 17084–17093) modeled the climatic perturbations caused by the two potential extinction drivers at the end of the Cretaceous period as well as their effects on dinosaur habitat suitability. The analysis found that a reduction in sunlight of 10–15% caused by an asteroid impact resulted in global cooling that would have virtually eliminated suitable dinosaur habitat worldwide. Heightened volcanism would have led to a much smaller reduction in sunlight that would likely have been insufficient to cause complete extinction by itself. Heightened volcanism would have also increased atmospheric CO_2, leading to global warming and an increase in dinosaur habitat suitability over the long term. Simulations combining an asteroid impact and heightened volcanism exhibited accelerated postimpact climate recovery compared with an impact in the absence of volcanism. The results suggest that the asteroid impact, not heightened volcanism, was the main driver of nonavian dinosaur extinction and that volcanically induced warming might have instead mitigated the effects of the impact, according to the authors. — B.D.

Artist's depiction of asteroid impact that caused end-Cretaceous mass extinction, viewed from space. Image credit: Gabriele Chiarenza (artist).

Weather and spring migration in birds

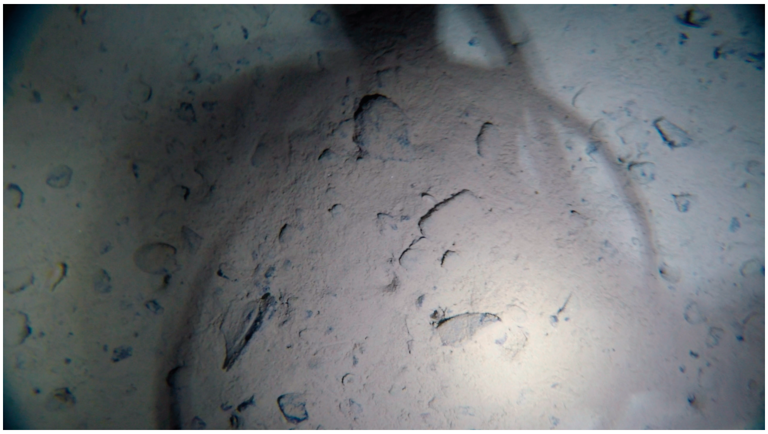
Populations of long-distance migratory birds are declining worldwide—a phenomenon thought to be driven by climate change, specifically the limited ability of long-distance migrants to advance their arrival timing at breeding grounds. However, data supporting the hypothesis are largely anecdotal and often contradictory. Birgen Haest et al. (pp. 17056–17062) assessed the potential influence of weather variables on spring migration patterns for six species of cross-continental migratory birds that passed through the island of Helgoland, Germany between 1960 and 2014. Weather conditions at wintering grounds and spring stopover areas accounted for approximately 80% of interannual variation in spring migration patterns. Wind and temperature were both strongly influential in terms of explaining

Spotted Flycatcher (*Muscicapa striata*) in Spain.

interannual variability in spring migration patterns. However, improvements in wind conditions were more important than rising temperatures in accounting for advancements in the timing of spring migrations over the 55-year period. Taken together, the results suggest that population declines for long-distance migratory birds are not likely attributable to an inability to advance the timing of spring migration in response to climate change. According to the authors, current evidence predominantly points toward anthropogenic land use change as a pathway by which climate change influences bird population sizes. — J.W.

Ocean mixing and ice melting under Ross Ice Shelf

Ocean water in the cavities beneath ice shelves contributes to ice shelf melting. Craig Stevens et al. (pp. 16799–16804) measured water column properties, including temperature, salinity, and oxygen isotope ratios, in the cavity beneath the center of the Ross Ice Shelf in Antarctica, the world's largest ice shelf by area, in December 2017. Water in this cavity had been previously sampled in the mid-1970s. The authors identified four distinct regions in the water column: a 20- to 40-meter homogenized benthic boundary layer, a 150-meter linearly stratified region, a 150-meter region of highly variable temperature and salinity structure, and a 30-meter basal boundary layer just beneath the ice. Imaging revealed a thin, ephemeral layer of ice crystals on the underside of the shelf. This finding, combined with temperature and salinity measurements in the basal boundary layer, suggests that this layer is close to the melting/freezing threshold. Below the basal boundary layer, interleaving salinity and temperature structures imply the existence of enhanced diffusion, which may have the potential to modify the expected cavity circulation and which appeared to be tidally modulated. The results provide insight into ice shelf cavity circulation and emphasize the importance of in situ measurements, according to the authors. — B.D.



Sea floor beneath the Ross Ice Shelf.

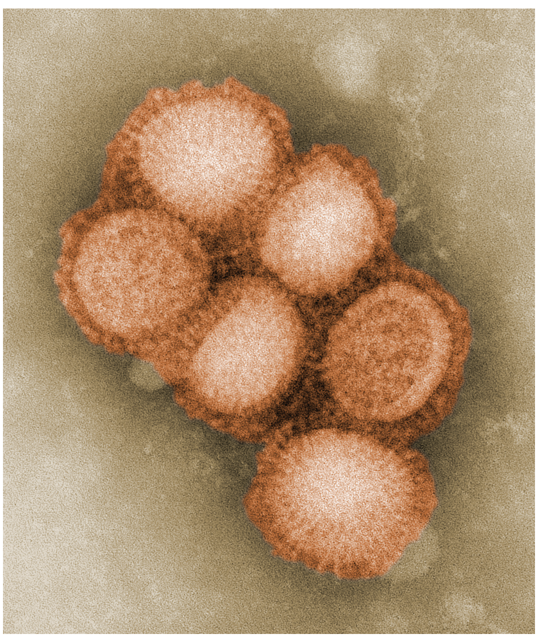
How bats cope with acoustic clutter

Bats locate objects by emitting ultrasonic sounds called broadcasts, which contain frequencies ranging from 25 kHz to 110 kHz, and listening to the returning echoes. Occasionally, an initial broadcast elicits a long-delay echo reflected from a distant object, and a closely successive broadcast triggers a short-delay echo from a nearby object. However, both echoes reach the bat's ears at nearly the same time. Chen Ming et al. (pp. 17288–17295) describe how bats deal with potential ambiguity in matching the echo to the correct broadcast. The authors trained four big brown bats to broadcast sonar sounds, which triggered loudspeakers placed on either side to deliver distinct simulated echoes consisting of various frequencies. To receive a reward, the bats had to approach the loudspeaker that delivered an echo simulating a nearby, insect-sized virtual object. Only the lowest broadcast frequencies of 25–30 kHz were necessary and sufficient for echo perception. The results explain how bats navigating cluttered environments easily distinguish between echoes elicited by two closely successive broadcasts. The authors note that only the second broadcast contains the lowest frequencies, and bats essentially ignore the faraway object represented by a long-delay echo elicited by the first broadcast. According to the authors, biologically inspired solutions could address the major challenge of designing radar and sonar systems that perform well in cluttered environments. — J.W.

Big brown bat. Image credit: BatLab.

Swine influenza virus with pandemic potential

Pigs are a key intermediate host, or "mixing vessel," in the development of pandemic influenza viruses, and surveillance of swine influenza viruses (SIVs) can help anticipate and prepare for human pandemics. Honglei Sun et al. (pp. 17204–17210) isolated 179 SIVs from pigs across 10 provinces in China from 2011 to 2018. The authors grouped the viruses into six genotypes, with the genotype resembling the prototypical Eurasian-avian H1N1 (EA H1N1) lineage (G1) predominating from 2011 to 2013. However, since 2016 the predominant viral genotype has been one incorporating elements from both the 2009 pandemic lineage and the North American triple-reassortant lineage. Viruses of this genotype, labeled G4 EA H1N1 by the authors, exhibited features characteristic of the 2009 pandemic lineage, including preferential binding to human-like SAα2,6Gal receptor, efficient replication in human airway epithelial cells, and high infectivity and transmissibility in a ferret model. The authors further found that of more than 300 serum samples from swine workers on 15 pig farms, 10.4% contained antibodies against G4 EA H1N1. The results suggest that G4 EA H1N1 has the potential for pandemic spread in humans and that measures to control this virus in pigs and closely monitor swine working populations should be swiftly implemented, according to the authors. — B.D.



Digitally colorized transmission electron micrograph of spherical virions from a 2009 pandemic influenza A (H1N1) virus isolate. Image credit: Centers for Disease Control and Prevention/C. S. Goldsmith and A. Balish.

Genetics of aggression in honey bees

As social animals, honey bees are influenced by the colony social environment, including hive defense. Arián Avalos, Miaoquan Fang, et al. (pp. 17135–17141) conducted a genome-wide association study

A gentle African queen bee (*Center Right*) from Puerto Rico traversing an empty comb with its male offspring (*Center Left*) amid its female offspring. Image credit: Manuel A. Giannoni Guzmán (Vanderbilt University, Nashville, TN).

of nine colonies of gentle African honey bees (gAHBs) from Puerto Rico, which recently evolved to be less aggressive than other African honey bee (AHB) populations. The authors did not observe significant associations between individual genotype and aggressive individual behavior. However, the authors found more than 1,100 genetic variants with colony-wide frequencies that were significantly associated with colony aggression levels in response to a simulated attack. The link was particularly strong for a region of chromosome 7 that contains several genes, including a gene homologous to the *dpr4* gene in fruit flies, which is involved in brain development. The chromosomal region exhibited a strong signature of selection for the evolution of gAHBs from AHBs, providing molecular evidence for the long-held idea that selection for aggression in bees occurs at the colony level. According to the authors, the findings suggest a novel approach to uncovering links between genetics and behavior for traits influenced by the social environment. — B.D.