In this issue . . .

Fine analysis of fur grooming in cats

Cat grooming fur. Image courtesy of Candler Hobbs (Georgia Institute of Technology, Atlanta).

Domestic cats, which sleep on average 14 hours each day, spend up to a quarter of their waking hours grooming, which removes fleas, debris, and excess heat from fur. Cats' tongues are carpeted with hundreds of sharp, scoop-shaped spines called filiform papillae, which are composed of keratin and spring into action during grooming. Alexis Noel and David Hu (pp. 12377–12382) used high-speed videos, CT scans, and grooming force measurements to explore how papillae aid grooming in postmortem tongue tissues from six cat species—domestic cat, bobcat, cougar, snow leopard, tiger, and lion. Experiments revealed that U-shaped hollows at the tips of papillae wick saliva from the mouth, each wicking action capturing up to 4.1 μL of saliva, tantamount to one-tenth of the drop of a typical eyedropper. Each lick of the tongue deposits nearly 50% of the fluid on the tongue onto fur and can deliver a substantive fraction of the cooling effect required for regulating body temperature. Further, the ease of grooming depends on whether papillae can penetrate fur to reach the skin, explaining why some species of domestic cats, such as long-haired Persian cats, are covered in fur that mats easily and is notoriously difficult to groom. Using the insights, the authors fashioned a cat tongue-inspired hairbrush that is easier to clean than human hairbrushes. According to the authors, the biologically inspired hairbrush might prove a handy implement to remove allergens from cat fur and apply cleaning lotions and medications on cat skin. — P.N.

Meteorite architecture suggests path to synthetic rare-earth magnets

Meteorites contain magnetic minerals, the crystalline structures of which reveal their thermal and magnetic histories. When certain iron–nickel alloys cool slowly, they can acquire nanoscale intergrowths of tetrataenite islands known as the "cloudy zone," a metallurgic feature that can be exploited as a sustainable replacement for rare-earth permanent magnets. Joshua Einsle et al. (pp. E11436–E11445) combined high-resolution tomography with computer simulations to uncover the 3D architecture of the cloudy zone and describe the mechanism that imbues this nanostructure with its signature magnetic properties. The authors found that in the cloudy zone three distinct crystallographic variants—each a specific clustering of islands—dictate how magnetic information is encoded in the cloudy zone. In addition, the authors describe a model for how the cloudy zone acquires remanence—the permanent residual magnetism leftover from the meteorite parent body. Based on the findings, the authors developed a theoretical blueprint to adapt a recently developed low-temperature nitrogen insertion and topotactic extraction process to fabricate synthetic tetrataenite nanocomposite as a sustainable permanent magnetic material. The findings suggest that synthetic analogs of the cloudy zone can be used for industrial applications, according to the authors. — T.J.

Shape formation in plants

The genetic and biomolecular mechanisms that give rise to complex 3D shapes in plant organs have been widely studied, but the role of biomechanical factors is unclear. Changjin Huang et al. (pp. 12359–12364) combined quantitative analyses of live plants with computational simulations to elucidate how mechanical stress and deformation influence plant leaf morphology. Within a leaf, growth strain, defined as the differential change in length between the center stem and a segment parallel to the stem, increased according to a power-law distribution from the center stem to the edge. Two parameters—the value of the power-law exponent that defines the strain profile and the maximum strain value—determined the leaf morphology in growth simulations. The authors constructed a phase diagram illustrating how each of four common leaf geometries—twisting, helical twisting, saddle bending, and edge waving—are associated with specific combinations of the parameters. By manipulation

Clamshell orchid (*Prosthechea cochleata*) with helical twisting petals. Image courtesy of Wikimedia Commons/D. Joshua Zampini.

of the two key parameters, the authors reproduced the geometries in a hydrogel, the formation of which mimics plant growth. The results provide a general framework for understanding shape formation in plant organs and suggest ways to generate bio-inspired structures in soft materials, according to the authors. — B.D.

Exon skipping helps treat inherited ciliary disorder in animal model

Joubert syndrome (JS) is a genetic disorder marked by retinal dystrophy, brain defects, and renal failure. The condition is caused by defective cilia, which are fine cell-surface protuberances that perform crucial physiological functions. Given that few preclinical approaches have successfully corrected the underlying genetic defects, Simon Ramsbottom, Elisa Molinari, Shalabh Srivastava, et al. (pp. 12489–12494) used a strategy called exon skipping to offset the effects of a mutated exon, or coding stretch of DNA, in the *CEP290* gene, implicated in JS. Using cells from a 14-year-old male patient, in whom a mutation in exon 41 of *CEP290* led to abnormally long cilia in renal epithelial cells, the authors performed exon skipping with targeted antisense oligonucleotides, which are DNA snippets designed to trigger exon skipping. The intervention resulted in production of properly localized, full-length CEP290 protein and restoration of normal ciliary length 48 hours after treatment. Antisense-mediated skipping of a different exon in *CEP290* in a mouse model of JS revealed that the approach can not only ameliorate defects in CEP290 protein production and cilia length but also reduce kidney cysts. Thus, exon skipping using antisense oligonucleotides can reverse pathological symptoms in patient-derived cells and an animal model of JS. According to the authors, the findings indicate the therapeutic promise of the strategy for inherited renal diseases tied to defective cilia. — P.N.

Competition among urban-adapted birds

Urbanization affects many species worldwide, but it remains unclear why certain species persist in urban habitats while others do not. Paul Martin and Frances Bonier (pp. E11495–E11504) examined how competitive interactions between bird species affect the birds' ability to survive and reproduce in cities. The authors compiled breeding occurrence data on nearly 300 bird species in 260 cities worldwide. Species were classified according to their propensity for breeding in cities, a measure of their degree of adaptation to urban environments, and whether they were dominant or subordinate in interactions with closely related species. Among urban-adapted species, dominant species were more widespread than subordinate species in cities where both types coincided. Dominant and subordinate species were equally prevalent in cities where their ranges did not overlap. The difference between dominant and subordinate urban-adapted species was largest in economically developed countries, while in developing countries, dominant and subordinate species were equally prevalent even when their ranges overlapped. According to the authors, the results suggest that asymmetric competition enables behaviorally dominant species to take advantage of urban habitats and exclude equally well-adapted subordinate species, and that economic development exacerbates this phenomenon. — B.D.

Blue Jay (*Cyanocitta cristata*), an urban-adapted species.