EDITED BY MARIA CRUZ AND SACHA VIGNIERI

ECOLOGY

Sharks Love Their Country

The return of individuals to the place of their birth to reproduce is called philopatry, and it occurs in many vertebrate species. Understanding the level, and details, of philopatry within a given species is important for conservation planning, particularly when it involves large, imperiled, and difficult-to-handle marine vertebrates, such as sharks. Feldheim *et al.* have undertaken an at-times arduous, 19-year survey of the coastal lemon shark, *Negaprion brevirostris*, around Bimini in the Bahamas. Previous genetic data hinted that this late-maturing species shows philopatry, and this study gathered direct evidence: Six recaptured mature female sharks were all, without exception, faithful to one nursery site or the other over multiple reproductive events. Such strong local fidelity would be expected to result in some degree of population isolation at very local scales, indicating a requirement for local conservation measures to match this faithfulness. — CA

Mol. Ecol. 10.1111/mec.12583 (2013).

CELL BIOLOGY

Centriole Central

The centriole is an evolutionarily conserved organelle involved in microtubule organization. Pairs of centrioles form the centrosome, which is the major microtubule-organizing center in interphase and the mitotic cells of higher animals. Centriole number is subjected to tight regulation, and aberrant centriole numbers cause genome instability and cell proliferation defects, leading to tumorigenesis and other diseases. The centriole also forms the basal body of the cilium, a microtubule-based tail-like membrane protrusion. Epithelial cells, such as those seen lining the trachea, contain many cilia on their apical surface. How are the hundreds of centrioles required for multiciliogenesis created? Zhao *et al.* examined multicilia formation in mouse tissues and cell lines using super-resolution three-dimensional structured illumination microscopy. Multiple centrioles were produced in ring-shaped deuterosome structures. Two related genes, *Cep63* and *Deup1,* were important for the generation of centrioles, with *Deup67* being essential for assembling the deuterosome structures required to create multiple centrioles de novo. *Cep63,* on the other hand, was more important for mother-centriole–based centriole duplication. — SMH

Nat. Cell Biol. **15,** 1434 (2013).

NEUROSCIENCE

Don't Sleep on It

Sleep deprivation has long been established as a helpful tool for the treatment of patients suffering from depression. However, how and why it works are still unknown. Functional magnetic resonance imaging (fMRI) studies have indicated that large-scale brain network connectivity, especially in the so-called default mode network, seems to be changed in depression. Bosch *et al.* investigated whether sleep deprivation could influence this brain connectivity. They discovered that sleep deprivation decreased functional connectivity between a brain area called the posterior cingulate cortex and the bilateral anterior cingulate cortex. In contrast, connectivity between the dorsal nexus, a region that plays a crucial role in the pathophysiology of depression, and two areas within the right dorsolateral prefrontal cortex was increased. These sleep deprivation–induced changes in resting-state connectivity indicate a shift in dominance from a more affective to a more cognitive network. This shift toward improved cognitive control should be particularly beneficial in depressed patients who suffer from rumination, negative anticipation, and excessive feelings of guilt and shame. — PRS

Proc. Natl. Acad. Sci. U.S.A. **110**, 19597 (2013).

MATERIALS SCIENCE

Glassy Dynamics

In the glassy state, atomic or molecular motion is limited to localized regions within an overall disordered structure. As a material is cooled toward its glass transition temperature, there is a rapid increase in the viscosity, which is marked by a slowdown of the atomic or molecular motions that is stronger than one would predict from a simple Arrhenius law. One theory is that as the glassy material is cooled, there is an increase in the number of correlated molecules that need to move together. This leads to a temperature-dependent activation energy, $E(T) = \exp(\Delta/T)$, where Δ can be thought of as an energy barrier. Bauer *et al.* measured the third-order nonlinear dielectric susceptibility for four materials that included one "strong" glass former and two "fragile" ones. The latter are of particular interest, because the energy barrier Δ itself shows an excess component that is also temperature-dependent. Surprisingly, they find that there is a simple correlation between $E(T)$ and the number of correlated molecules, largely independent of the molecular interactions within each material. The formation of the glassy state and the rapid viscosity rise are thus primarily due to an increase in the number of atoms or molecules, whose motions couple together as the temperature is lowered. — MSL

Phys. Rev. Lett. **111**, 225702 (2013).

ASTRONOMY

Bright Young Thing

Circinus X-1, a binary star system that includes a neutron star, is one of the brightest x-ray sources in the sky. Heinz *et al.* now report that this x-ray

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binary is the youngest known yet. Data from the Chandra X-ray Observatory and from the Australian Telescope Compact Array, a radio telescope composed of six 22-m antennas, show that the neutron star is still within the supernova remnant in which it was born. A supernova remnant, the radiating material that is left after a star explodes at the end of its life, does not stay visible for very long. In this case, the age of the remnant constrains Circinus' age to less than 4600 years. Such a young age explains the system's rapid orbital evolution and highly eccentric orbit, which had been puzzling. There has not been enough time

yet for the orbit to be tidally circularized from the eccentricity it received in the explosion. Because the neutron star is known to have a low magnetic field, the young age also implies that neutron stars can be born with low magnetic fields or can easily become demagnetized. — MJC

Astrophys. J. **779**, 171 (2013).

PHYSICS

Mind the Gap

One of the basic characteristics of a superconductor is the energy needed to break up Cooper pairs, which form the superfluid flow in these materials. In conventional superconductors such as Nb, this energy, twice the size of the so-called superconductor "gap," does not depend on the momenta of the electrons forming the pair; however, in cuprates, for example, the gap disappears entirely at certain points in momentum space. The symmetry of the gap in iron-based superconductors is still under debate, and there are indications that it might not be the same for all of them. Yang *et al.* used scanning tunneling spectroscopy to observe the evolution of the local density of states (LDOS) near a nonmagnetic impurity dopant (Cu) in the material $Na(Fe_{0.96-x}Co_{0.03}Cu_x)As$. The effect of a Cu impurity on LDOS appeared to be a pronounced enhancement near 2 meV, inside the superconductor gap. Such in-gap states near nonmagnetic impurities are consistent with the gap symmetry, where the electron and hole pockets of the Fermi surface have opposite signs of the gap function; the authors performed magnetization measurements to demonstrate that the Cu impurities are indeed nonmagnetic. Comparison to theory indicated that the results were incompatible with other proposed gap symmetries, which may have implications for the mechanism of superconductivity in these materials. — JS

Nat. Comm. **4**, 2749 (2013).

IMMUNOLOGY

Nanotoxoids

Some bacteria, such as *Staphylococcus aureus* and *Escherichia coli*, release toxins that punch holes into membranes to kill cells. Vaccines against such pore-forming proteins have generally used toxins that are inactivated by heat or chemicals to elicit a protective immune response. Although these treatments generate a safe vaccine, they can destroy key antigenic epitopes, thus weakening the immune response. Hu *et al.* have taken an alternative approach. The authors coated polymer nanoparticles with membranes from mouse red blood cells. The particles then absorbed undenatured staphylococcus alpha-hemolysin (Hla) toxin into the membrane coating. The nanotoxoids were stable and could be taken up by mouse dendritic cells, the immune cells that normally process antigen. Unlike Hla, the nanotoxoid particles did not kill cells when injected into the skin of mice. The particles also triggered the production of antibodies to Hla in mice, but avoided provoking an autoimmune response to other membrane constituents. The immune response also protected animals from a lethal dose of Hla. After a single vaccination and two booster shots, 100% of Hla-treated mice survived. A nanoparticle-based immunoengineering approach could be used to develop a broad range of anti-toxin vaccines. — LC

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