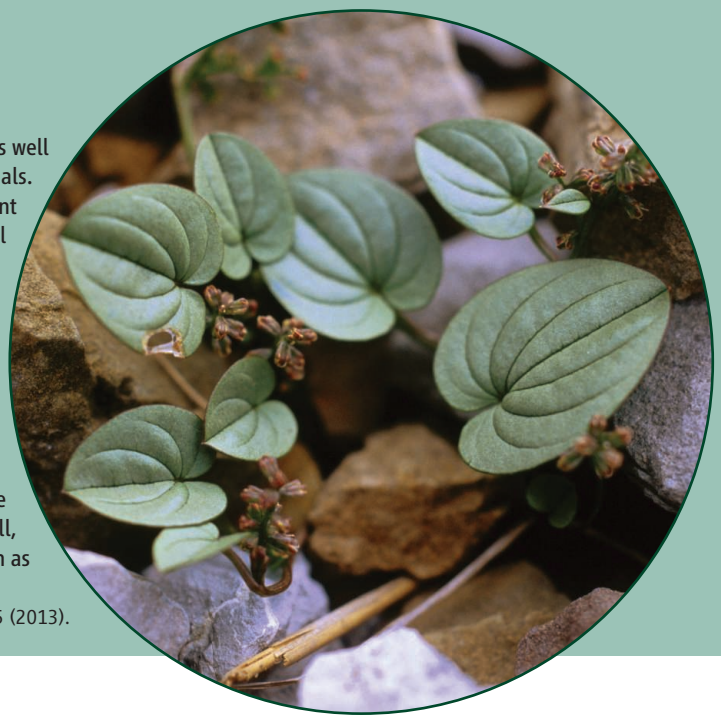
EDITED BY KRISTEN MUELLER AND MARIA CRUZ

ECOLOGY

Secrets of Long Life



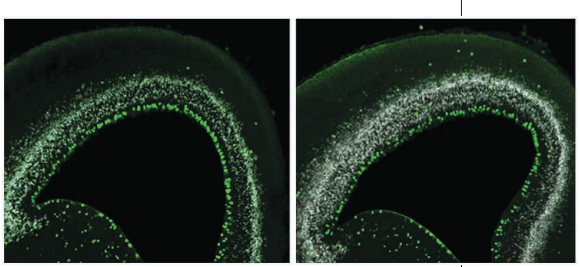
The accumulation of reactive oxygen species (ROS) causing oxidative stress is well known as one of the factors associated with senescence, particularly in animals. Oxidative stress has also been shown to be associated with senescence in plant organs (leaves and flowers). However, much less is known about its potential for affecting the senescence of whole plants, especially longer-lived perennials. To address this gap, Morales *et al.* studied photo-oxidative stress markers in an exceptionally long-lived herbaceous species, *Borderia pyrenaica,* which inhabits scree slopes in the Pyrenees and reaches ages of more than three centuries. The markers of oxidative stress were measured in both male and female plants over an age range of 1 to 245 years. None of the markers showed any signs of deterioration in older plants and were even enhanced in some aged female plants. Though it is possible that intrinsic physiological stress mechanisms exert their effects at even greater ages beyond those addressed in this study, mortality in this species—and perhaps in other small, long-lived perennials—may ultimately depend more on extrinsic factors such as pathogens, physical disturbances, and climatic extremes. — AMS

J. Ecol. **101**, 555 (2013).

DEVELOPMENTAL NEUROSCIENCE

To Fold or Not to Fold

The surface of the normal human brain is characterized by deep and complex folds. Ferret brains are similarly gyrencephalic, whereas mouse brains are smooth-surfaced, or lissencephalic. During development, proliferation of different subtypes of stem and progenitor cells



shapes the brain surface. In order to understand the relative contributions of these different progenitor cell types, Nonaka-Kinoshita *et al.* manipulated the proliferation of these cells at different times during the brain development of mice and ferrets. Mice with an excess of basal progenitors had thicker brain layers but, despite an increase in brain surface area, the surface remained smooth. In contrast, ferrets with excess progenitor activity developed more brain folds than control mice. In both species, neuronal specification and the structure of brain layers remained normal. Thus, the brain's surface area and the amount of folding may be regulated by progenitor activity, but the distinction between lissencephalic or gyrencephalic brains is not simply due to the number of progenitors. — PJH

EMBO J. 10.1038/emboj.2013.96 (2013).

ASTRONOMY

A New River in the Sky

Stellar streams are found throughout the outskirts of our galaxy. They are thought to be disrupted dwarf satellite galaxies or clusters of stars and are proof that the Milky Way formed in part by accreting smaller collections of stars. Based on data from two different all-sky surveys, Grillmair *et al.* have found a new, 24°-long, stellar stream running through the southern constellations of Phoenix, Eridanus, Hydrus, and Tucana. Named Alpheus, after the river in Homer's *Iliad*, this stream is estimated to be about 6200 light-years away—much closer than the stellar streams found so far in our galaxy. It is likely that Alpheus is associated with the globular cluster NGC 288, a family of stars that is thought to be in the process of breaking apart. If this is the case, further characterization of the stream will enable better modeling of the orbit of NGC 288. — MJC

Astrophys. J. **769**, L23 (2013).

NEUROSCIENCE

Lingering Pain

Neuropathic pain results from injury or disease in the nervous system and is estimated to affect more than 2 million people in the United States. The pain can linger, but the mechanisms for such persistence are not well defined. Qiu *et al.* studied a mouse model in which injury to a peripheral nerve caused behavioral effects that lasted for weeks, in which mechanical stimuli that were normally not noxious would cause pain. They looked for effects of this treatment in a brain region called the insular cortex. This region is implicated in pain sensation, and direct stimulation of the insular cortex in humans causes pain sensation. The authors found that signaling responses to neurotransmitters were altered in animals that had experienced the nerve injury. Neurotransimitter receptors activated by NMDA (*N*-methyl-D-aspartate) were phosphorylated on tryrosine residues and accumulated in synapses of the insular cortex. The injection of inhibitors of NMDA receptor signaling into the insular cortex decreased the hypersensitivity to pain in the treated mice. Such insights may help direct new therapeutic approaches to managing neuropathic pain. — LBR

Sci. Signal. **6**, ra34 (2013).

OCEAN SCIENCE

Mysterious Rise

The concentration of atmospheric carbon dioxide (CO_2) rose from about 180 parts per million by volume (ppmv) to 280 ppmv between the end of the Last Glacial Maximum and the Holocene. It is widely believed, largely based on measurements of the ^{14}C in the CO_2 of air trapped in polar ice and of forams from marine sediments, that the atmospheric CO_2 rise was caused in large part by ventilation of old, CO_2-rich water from the deep Southern Ocean. Tessin and Lund analyzed another isotope of carbon, ^{13}C, to show that the mid-depth waters along the Brazil Margin

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underwent an abrupt change in their inventories of ^{13}C during the initial 30-ppmv increase in CO_2 between about 17,000 and 16,000 years ago. These data, collected from analyses of planktonic forams in marine sediments, in conjunction with data on the oxygen isotopic composition of these waters, suggest that two distinct water masses must have influenced the mid-depth Atlantic Ocean during that interval and that a previously unrecognized source of carbon outside of the ocean-atmosphere system may have been involved. The authors also inferred that the release of carbon into the atmosphere from a reservoir depleted in ^{13}C must have been a key trigger of the last deglaciation. — HJS

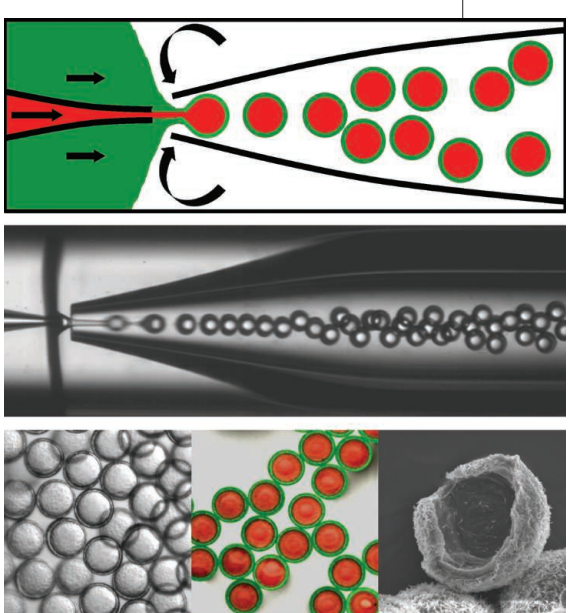
Paleoceanography 10.1002/palo.20026 (2013).

CHEMISTRY

Tiny Cocktails

The effective treatment of many diseases, especially cancer and AIDS, requires the synergistic interaction of several drugs; their delivery is often referred to as a "cocktail." Although several drugs can be combined into one delivery agent, the different rates of systemic uptake, solubility, and clearance make it challenging to deliver all of the drugs simultaneously. Windbergs *et al.* have used a microfluidic platform to create core-shell particles in which a hydrophobic drug (paclitaxel) forms the shell and a hydrophilic drug (doxorubicin hydrochloride) is carried in the core. The particles, which have an overall diameter of less than 100 μm, were made with two glass capillaries drawn to fine tips inside a microfluidic channel. The finer capillary (with an ~20-μm opening) held an aqueous solution of the core drug on the inside, and the fluid outside this capillary carried the shell drug dissolved in a food-grade lipid. This capillary tip pointed toward the opening of a wider tip (with an ~100-μm opening) facing the opposite direction. The action of a third solvent (a solution of polyvinyl alcohol in water) on the outside of the larger capillary drew in both fluids from the smaller one and created the core-shell droplets. The particles were stable upon drying and could be processed to form free-flowing powders. The viability of the drugs was confirmed in testing on immortalized human cervical cancer cell lines. Delivery in the body can be tuned by using a lipid that melts near body temperature or by relying on lipid degradation in the gastrointestinal tract. — PDS

J. Am. Chem. Soc. 10.1021/ja401422r (2013).



CREDIT: M. WINDBERGS *ET AL.*, *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY* (30 APRIL 2013) © 2013 AMERICAN CHEMICAL SOCIETY

NEUROSCIENCE

Fasting Protects the Brain

Fasting has been shown to slow aging in a number of species. Caloric restriction acts on many different cell types and tissues and, importantly, also on the brain. There, it leads to a slowing-down of age-associated pathologies, such as brain atrophy or loss of synaptic plasticity. Moreover, in several animal models, a reduced consumption of calories seems to protect against cognitive deficits such as memory loss. However, it is not known whether caloric restriction can delay the beginning of neurodegeneration. The mechanisms underlying these observations are also largely unclear. In experiments using genetically modified mice, Gräff *et al.* found that caloric restriction effectively delayed the onset of neurodegeneration and preserved structural and functional synaptic plasticity as well as memory capacities. Fasting activated the expression and activity of the nicotinamide adenine dinucleotide (NAD)–dependent protein deacetylase SIRT1, a known promoter of neuronal life span. Surprisingly, this effect of reduced consumption of calories could be mimicked by a small-molecule SIRT1-activating compound. Mice treated with this substance recapitulated the beneficial effects of caloric restriction against neurodegeneration-associated pathologies. If this mechanism also applies to humans, SIRT1 may represent an appealing pharmacological target against neurodegeneration. — PRS

J. Neurosci. **33**, 8951 (2013).

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Fasting Protects the Brain

Peter Stern

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