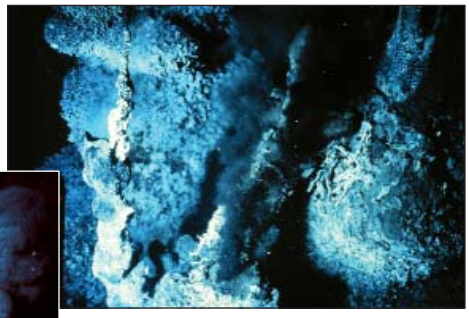
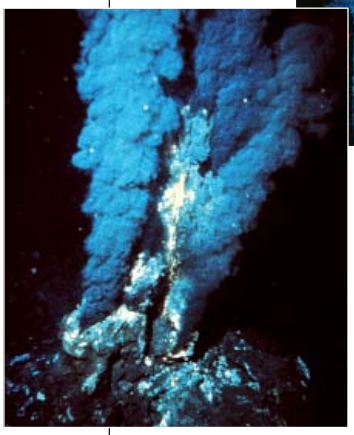
EDITORS' CHOICE

edited by Stella Hurtley





A possible site for prebiotic dinitrogen reduction.

CHEMISTRY

Nitrogen in a Fix

Nitrogen-fixing bacteria are able to convert dinitrogen (N_2) to ammonia (NH_3) under gentle conditions with the help of the enzyme nitrogenase. High-resolution structures have revealed that this enzyme contains iron-sulfur and iron-sulfur-molybdenum clusters in the active site. Can this biochemical process be traced back to a prebiotic mechanism of nitrogen reduction involving iron-sulfur compounds?

Dörr *et al.* report that ammonia can be made in low yield (0.1%) from dinitrogen in the presence of hydrogen disulfide (H_2S) and freshly precipitated iron sulfide (FeS). The reaction conditions (atmospheric nitrogen pressure and 80°C) are comparable to those of the biological process and much milder than in previously reported ammonia syntheses. Commercially purchased or aged iron sulfide did not fix nitrogen, suggesting that the rugged surface of the freshly precipitated material provides a "library of Fe-S clusters" that are crucial for the reaction to take place. Given the large amounts of iron sulfide and hydrogen disulfide available on early Earth, a reaction similar to the one described may have played a role in the prebiotic formation of ammonia. — JFU

Angew. Chem. Int. Ed. **42**, 1540 (2003).

CLIMATE SCIENCE

Historical Soot

Black carbon particles are a product of incomplete combustion; hence black carbon emission levels reflect how efficiently fuel is burned as well as how much fuel is consumed. Because these particles are the principal light-absorbing atmospheric aerosol, any analysis or prediction of climate variability must include an accurate atmospheric inventory of this species.

Novakov *et al.* present estimates of fossil-fuel black carbon emissions from the United States, United Kingdom, Germany, Soviet Union, India, and China for the period from 1875 to the present. These countries account for the majority of global consumption of coal and diesel fuel, which are the principal black carbon–producing fossil fuels. Emissions increased in the latter part of the 1800s, leveled off in the first half of the 1900s, and increased again in the past 50 years as China and India developed. Historical changes in fuel utilization have caused large variations in aerosol absorption, leading to substantial changes in aerosol single-scatter albedo in some regions and suggesting that anthropogenic black carbon production may have contributed to global temperature changes in the past century. — HJS

Geophys. Res. Lett. **30**, 1324 (2003).

ANTHROPOLOGY

Early Arrivals

Most of the dates of when humans arrived in the New World are radiocarbon dates of organic material that brackets artefacts (for example, the Clovis points) or of cultural horizons. There are few human remains available, which is one reason for the heated debate over possession and sampling of Kennewick Man, who lived in what is now the state of Washington about 9500 years ago [a radiocarbon age of about 8500 years before the present (yr B.P.)] Such samples are important for direct comparison with potential ancestral populations in the Old World, for assessing the diversity of the early populations, and, potentially, for direct analysis of ancient DNA. Perhaps the richest collection of remains comes from several sites in central Mexico, but obtaining accurate dates on these early inhabitants has been problematic. Gonzalez *et al.* report successful radiocarbon dating of 4 out of 11 individuals. The uncalibrated radiocarbon ages for the two oldest individuals are around 10,200 to 10,800 yr B.P., or about 12,800 calendar years ago, making these some of the oldest remains recovered in the New World. — BH

J. Hum. Evol. **44**, 379 (2003).

MICROBIOLOGY

Folding Filaments

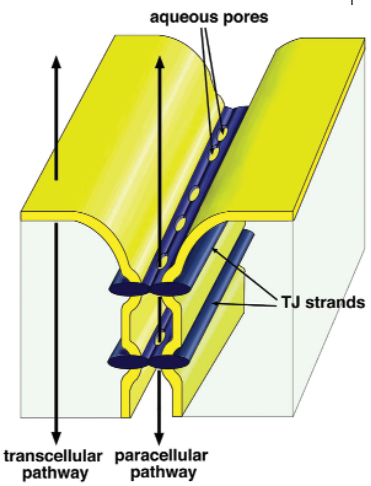
Under conditions that would blow apart the cells of metazoans, many Archaea and Eubacteria achieve remarkable feats of endurance with subtle, almost undetectable changes in biochemistry and physiology. It has been thought that, under stressful conditions, chaperonins are induced to refold damaged proteins, but Kagawa *et al.* contest this belief. Chaperonins are composed of heat shock protein (Hsp60) subunits that assemble into double ring structures. The hyperthermophilic archaean *Sulfolobus shibatae* likes to grow at about 80°C. When it is exceptionally hot (>86°C), these rings are composed mainly of Hsp subunits alpha and beta, which assemble into rings that then form filaments. When it's cooler (<60°C), the proportion containing gamma Hsp subunits increases; this combination is less stable, and shorter, more flexible filaments form, which may have more to do with membrane stability or fluidity than protein folding.— CA

Mol. Microbiol. **48**, 143 (2003).

CELL BIOLOGY

How Tight is Tight?

Epithelial cells in single (simple) and multiple (stratified) layers function as barriers that define internal fluid compartments, such as the intestine, or that protect the body from the external environment, such as the skin. The transcellular passage of small molecules across the lipid bilayer is facilitated by transport proteins. Similarly, the paracellular movement of ions is restricted by tight junctions, which appear as juxtaposed strands and consist primarily of the membrane protein claudin.



Schematic of tight junction (TJ) structure in epithelia.

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By expressing a fluorescent claudin in fibroblasts, Sasaki *et al.* show that tight junction strands are dynamic structures that separate and come together even though the claudins within a strand appear to be stably associated. How the paracellular barrier is both maintained and regulated under these conditions will be of interest. — GJC

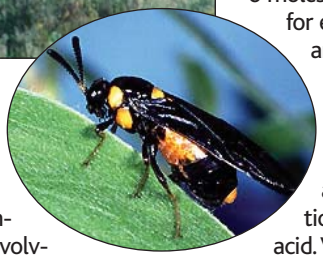
Proc. Natl. Acad. Sci. U.S.A. **100**, 3971 (2003).

ECOLOGY/EVOLUTION

Connected via the Web

Although ecological systems, almost by definition, consist of complex webs and chains of interactions among multiple species, it is not necessarily simple to document and quantify these interactions. Bailey and Whitham investigated a system involving four very different groups of organisms—mammals, trees, arthropods, and birds—in Arizona. The patterns of insectivorous bird predation were altered by elk browsing on aspen trees, because the consumption of aspen shoots by elk reduced the quantities of galls produced by sawflies, the presence of which had significant and positive effects on the species richness and abundance of other arthropod species. These results, achieved by a combination of observation and experiments in which elk were excluded and browsing was simulated, show how the system is governed by a combination of top-down and bottom-up effects, and how the indirect manipulation of one species (sawfly) by another (elk) can have effects that ramify throughout the community. — AMS

Web browsers.



OIKOS **101**, 127 (2003).

CHEMISTRY

Cheaper by the Half-Dozen

The value of many primary chemical feedstocks can be limited by the value of byproducts that must also be sold. For example, the current synthesis of methanesulfonic acid (MSA) proceeds by means of the chlorine oxidation of methylmercaptan, and 6 moles of hydrochloric acid are produced for every mole of MSA. Mukhopadhyay and Bell report on a method in which methane is sulfonated directly, thereby avoiding the production of chlorine-containing byproducts. They use SO_2 as the sulfate source and $K_2S_2O_8$ as an oxidant; the reactions are run at high pressure in triflic acid. Various calcium salts, which have been shown to be effective catalysts in methane carbonylation, were tested, and the highest yields (22% conversion after 26 hours of reaction) were obtained with CaO_2. Further efforts will be directed at replacing $K_2S_2O_8$ with O_2 as the oxidant. — PDS

J. Am. Chem. Soc. 10.1021/ja0281737 (2003).

HIGHLIGHTED IN *SCIENCE'S* SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

Science's stke www.stke.org

Dissecting Growth Cone Guidance

The growth cones of developing neurons take twists and turns as they strive to reach their targets. Their paths are marked by attractive and repulsive cues (chemotropic ligands) that they encounter along the way. These ligands activate receptors on the surface of the growth cone. Campbell and Holt report that in cultured *Xenopus* retinal growth cones, three different chemotropic ligands—netrin-1, semaphorin3A (Sema3A), and lysophosphatidic acid (LPA)—stimulate distinct, but overlapping, signaling pathways. Netrin-1 and Sema3A activated the p42 and p44 mitogen-activated protein kinases (MAPKs). The p38 MAPK, normally associated with stress responses, was activated in cells treated with netrin-1 or LPA. Studies with antibodies to the active, cleaved form of caspase-3 revealed that caspase-3 was activated in response to LPA or netrin-1. The authors discuss the potential role of caspase-3—better known as a component of pathways leading to apoptosis or cell death—in axon guidance and note similarities between the chemotropic pathways implicated in this work with those thought to regulate synaptic plasticity. — LBR

Neuron **37**, 939 (2003).

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How Tight is Tight?

Science **300** (5617), 215-217.
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