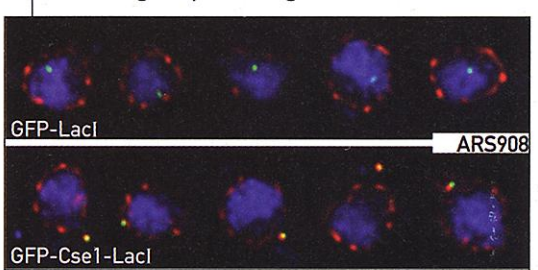
EDITORS' CHOICE

edited by Gilbert Chin

MOLECULAR BIOLOGY

The Bounds of Silence

Recent advances in visualizing intranuclear structure have revealed that the positions of chromosomal regions correlate with their transcriptional activity. That is, heterochromatic regions that are relatively inactive (or silenced) reside near the inside face of the nuclear membrane, whereas actively transcribing chromatin is generally found closer to the nuclear core. A striking confirmation of this architectural principle has been provided by Tanabe *et al.*, who show that the nuclear localization of gene-poor and gene-dense regions, currently found in human chromosomes 18 and 19, respectively, has been conserved across humans and higher primates despite large-scale chromosomal rearrangements during evolution.



Incorporating Cse1 (bottom) in a LacI construct (top) links a genomic locus (green) to the NPC (red).

Ishii *et al.* now demonstrate that the interaction of boundary elements (which flank genes) with components of the nuclear pore complex (NPC) stimulates transcription of the bounded gene, counteracting the global silencing effect of heterochromatin. This interaction can occur either indirectly through the exportin protein Cse1 (and also through other members of the transportin family) or directly at the NPC basket via the Nup2 protein (but not via two other basket-associated proteins, Mlp1 and Mlp2). How the localization of these chromosomal regions might affect gene expression is not yet clear; the authors suggest that visiting the NPC neighborhood exposes a genomic domain to activating factors, such as histone acetyltransferases, and also facilitates the funneling of cytoplasmic signals to their genetic targets. — GJC

Proc. Natl. Acad. Sci. U.S.A. **99**, 4424 (2002); *Cell* **109**, 551 (2002).

EVOLUTION

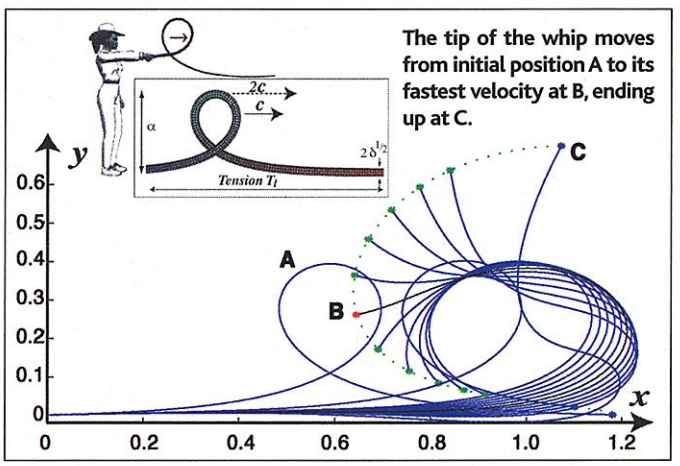
Humans, Flies, and Worms

Nematode worms are an abundant and diverse group of organisms that inhabit a wide range of ecosystems, and *Caenorhabditis elegans* is used widely as model system. Nevertheless, the evolutionary relationships of nematodes to other animal groups have remained controversial. Earlier analyses based on morphology and developmental patterns placed nematodes at a distance from animal groups with true body cavities (coeloms), but more recent analyses of ribosomal gene sequences instead implied closer links to arthropods—a coelomate group—and led to the proposal of a superphylum of molting animals or Ecdysozoa. Blair *et al.* compared sequences of more than 100 nuclear proteins, and their analyses support the traditional model of nematode phylogenetic relationships, placing arthropods closer to vertebrates than to nematodes, and nematodes distant from both. — AMS

BMC Evol. Biol. **2**, 7 (2002).

PHYSICS

Cracking the Whip



Many explanations of how the tip of a bullwhip is accelerated to supersonic speeds include hand-waving (or perhaps arm-waving) arguments and rely on kinematic analysis of the conservation of energy or of linear or angular momentum. In fact, all three quantities are conserved, and a full dynamical treatment is needed to satisfy conservation constraints as well as the known requirements for a good whip, such as a tapered shape. Goriely and McMillen provide a numerical analysis of a loop traveling down a whip and show how this leads to rapid acceleration of the tip. They show that the tip can reach velocities more than 30 times that of the initial velocity, well in excess of the speed of sound. — PDS

Phys. Rev. Lett. **88**, 244301 (2002).

GEOLOGY

The Last Habitat

Some of the first animals burrowed through marine sediments in search of food and shelter. These animals, though rarely preserved, left telltale tracks and stirred up finely laid sediments; however, colonization of sediments in freshwater rivers and lakes by burrowing animals proceeded much more slowly. Miller *et al.* surveyed 10,000 terrestrial sediment samples deposited from the Permian to the Jurassic and found scant evidence of burrowing animals. The few inferred to be present appeared to have moved parallel to the surface and thus did not disturb the bottoms of lakes and rivers or enhance the flux of minerals and organic matter between water and sediment. Today, burrowing fresh water animals are abundant; evidently, they arose and multiplied in the late Mesozoic (about 100 million years ago), long after other habitats (fresh water, land, and air) had been exploited. — BH

Geology **30**, 527 (2002).

ASTROPHYSICS

An Interstellar Trifecta

In the emptiness of interstellar space, very cold, very dense, and very dark molecular clouds hide important and unusual molecular species that condense onto icy dust grains; these mysterious clouds may also harbor the beginnings of star formation. Identifying the condensed species

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CREDITS: GORIELY AND MCMILLEN, *PHYS. REV. LETT.* **88**, 244301 (2002); ISHII *ET AL.*, *CELL* **109**, 551 (2002)

and the chemical processes (many of which do not occur in the terrestrial environment) that produce them is critical for assessing the elemental abundances in the interstellar medium, but Earth-based observations favor detection of energetic molecules in the gaseous phase.

It comes as a surprise, therefore, that Lis *et al.* and van der Tak *et al.* have found triply deuterated ammonia, ND_3, in the Barnard 1 and NGC 1333 clouds by using high-resolution spectroscopy at the Caltech Submillimeter Observatory. Modeling suggests that ND_3 may be formed from a series of ion-molecule reactions in the gas phase because hydrogen has a higher probability than deuterium of being ejected after partially deuterated ions collide. ND_3 may also arise from grain surface chemistry and be converted to a gaseous phase by youthful radiation from a protostellar wind. The gas phase D/H for this pathway would be much higher than expected, requiring new models of the chemistry of star formation. — LR

Astrophys. J. **571**, L55 (2002); *Astron. Astrophys.*, in press (astro-ph/0204448).

ECOLOGY/EVOLUTION

Life in a Field of Daisies

The sixth mass extinction in our planet's history appears imminent—precipitated, unlike the previous episodes, by human activity. To deepen our understanding of ecosystem resiliency and to explore how we might mitigate the effects of extinction are the aims of a collection of theoretical articles compiled by Solé and Levin. The main thrust of the argument is that ecosystems are complex adaptive systems that follow universal principles of organization.

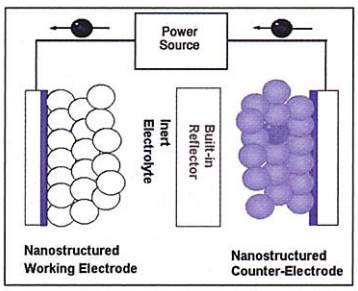
James Lovelock propounded Gaia as a paradigm for the coupling between life and the physical environment of Earth, encompassing the biosphere. In their contribution, Lenton and van Oijen contend that Gaia may be the largest complex adaptive system in a hierarchy that includes cells, organisms, populations, and ecosystems. They have added albedo mutation to the original Daisyworld model (of black and white daisies) for Gaia, and they show that variation and natural selection operate through feedback to dampen instability as adaptive behavior emerges. They also point out that, although the biosphere lies far from equilibrium and major events have suppressed biodiversity in the past, the system has always recovered without losing the capacity to capture free energy or to cycle elements. But this may be poor solace for humans facing the consequences of extinction. — CA

Philos. Trans. R. Soc. London B **357**, 617; 683 (2002).

APPLIED PHYSICS

A Replacement on Paper

Flat panel displays used in laptops and personal organizers are increasing both in resolution and in size, but, for applications requiring larger areas, such as newspapers, these expensive technologies are less suitable. Bach *et al.* describe one approach toward the development of electronic paper in which they use a textured, transparent conducting electrode decorated with electrochromic molecules and encapsulated with a counterelectrode as the active switching elements. Application of a small bias (a couple of volts) to the electrode changes the optical properties of the chromophores from light to dark to form alphanumeric and text displays on a suitably patterned electrode. Moreover, the switching is relatively rapid, taking only tens of milliseconds. This approach may lead to fast, low-power consumption electronic paper displays. — ISO



Schematic of an electrochromic device.

Adv. Mater. **14**, 845 (2002).

MOLECULAR BIOLOGY

Human Mediation

Several classes of protein complexes are needed to turn on gene expression, including general transcription factors, activators, and coactivators. Mediator is a coactivator complex in yeast that does not bind directly to the promoter region of the DNA, but instead acts as a bridge between activators and the COOH-terminal domain (CTD) of RNA polymerase II (the core of the transcription machine). The human co-activator required for Sp1 activation (CRSP) is known to interact with activators, and Näär *et al.* show that it binds to the CTD of human RNA polymerase II. Thus, although human CRSP and yeast Mediator are dissimilar in polypeptide composition and structure, they appear to function in similar ways by helping to recruit the RNA polymerase machine to the promoter. — BAP

Genes Dev. **16**, 1339 (2002).

CREDITS: BACH *ET AL., ADV. MATER.* **14**, 845 (2002)