EDITORS' CHOICE

edited by Stella Hurtley

ECOLOGY

A Climate for Extinction

Throughout evolutionary history, climate change has been an important force in the evolution and extinction of populations and species. Extinction may occur through failure to adapt to new conditions or through an inability to track geographical shifts in hospitable regions. Anthropogenic climate change is expected to exacerbate the current global extinction crisis.

Now McLaughlin *et al.* have provided an early indication of an extinction caused by contemporary climate change. Over a 40-year study period, two populations of checkerspot butterflies in the San Francisco Bay Area, California, gradually declined to extinction as the annual variability in rainfall became more unpredictable. A population-modeling exercise showed that precipitation variability led to increased population fluctuations in the butterfly, which increased the likelihood of extinction when population size dipped below a critical level. Climate models indicate that increased variability is an expected component of human-induced climate change. The fate of the checkerspot might therefore portend similar extinctions in the future. — AMS

Proc. Natl. Acad. Sci. U.S.A. 10.1073/pnas.052131199 (2002).

EARTH SCIENCE

Land Ho

Major changes are required to move from life under water to life on land. The first clear terrestrial animal fossils are early arachnids and centipedes from about 420 million years ago. These fossilized arthropods show sufficiently developed features that it is likely that an earlier evolution occurred.

Now MacNaughton *et al.* describe tracks in wind-derived sandstone from near the Cambrian-Ordovician boundary (about 505 million years ago). The tracks appear to have been made by large amphibious arthropods several centimeters across. Although the dunes forming the sandstone were probably close to a seashore and these tracks are likely to represent only temporary excursions on land, they do indicate that colonization of the nonmarine environment may have proceeded fairly rapidly after complex animal life evolved in the oceans. — BH

Geology **30**, 391 (2002).

NEUROSCIENCE

Motivation and Working Memory

When trying to accomplish any kind of task, people usually need both to be motivated and to generate a plan as to how to proceed.

Pochon *et al.* used fMRI to investigate the brain structures involved in the motivational and cognitive aspects of goal-directed actions. Volunteers performed working memory tasks at different levels of complexity. These tasks were randomly associated with different degrees of reward. The working memory paradigm activated well-known working memory areas in the dorsolateral prefrontal cortex. Under more difficult conditions, lateral frontopolar regions were also recruited. High reward conditions elicited additional activation in areas already activated by working memory. Other areas showing a correlation with the degree of reward, independent of the level of executive demand, included the anterior cingulate cortex and the frontal pole. However, several brain areas belonging to a paralimbic network, including the medial prefrontal cortex, ventral prefrontal cortex, hippocampus, and temporal pole, showed deactivation correlated with higher cognitive demand and higher reward levels. These deactivations could perhaps be explained by an emotional gating function necessary to free cognitive areas and optimize their performance. — PRS

Proc. Natl. Acad. Sci. U.S.A. **99**, 5669 (2002).

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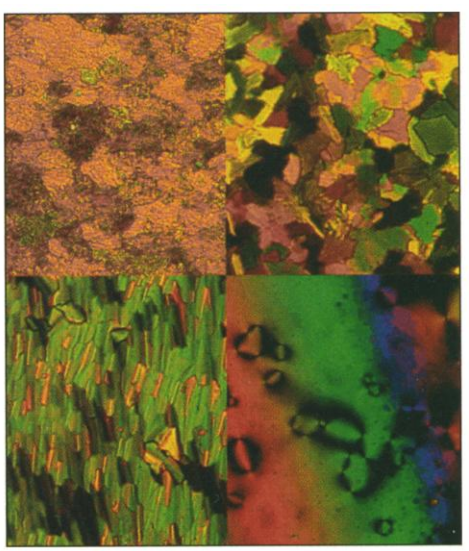
MATERIALS SCIENCE

Complex Discs

Molecules that exhibit liquid crystalline phases are known as mesogenic and possess an inherent rigidity that encourages their packing into semi-ordered arrays. The extent of ordering can be controlled by changing external variables such as temperature and pressure, whereas small changes in the molecular structure will vary the number and nature of liquid crystalline phases that are observed. For example, by coupling a mesogen to a polymer backbone, the number of liquid crystalline phases and the temperature range over which they are observed can increase because the polymer backbone suppresses crystallization. Rod-shaped molecules are the more common architecture, but disc-shaped molecules are receiving increased attention because of their potential for display technologies and as one-dimensional charge carriers.



Optical textures from a liquid crystalline acceptor pair at varying temperature.

Kouwer *et al.* have expanded the family of discotics by creating a molecule with a single functional tail and five methoxy substituents. On its own or coupled to a polymer backbone, the mesogen showed only one liquid crystalline phase. However, mixing the mesogen with a number of charge acceptor molecules increased the number and complexity of liquid crystalline phases that formed. Surprisingly, examination of the phases by x-ray diffraction and polarized optical microscopy often gave conflicting results as to the type of liquid crystalline phase present, suggesting that caution is needed when studying these more complex liquid crystalline materials. — MSL

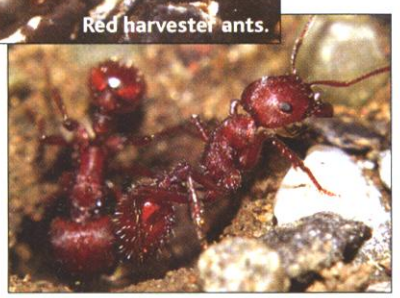
Macromolecules 10.1021/ma0118567 (2002).

CREDITS: EDWARD S. ROSS/CA ACADEMY OF SCIENCE; (TOP) KOUWER *ET AL.*, *MACROMOLECULES* 10.1021/MA118567 (2002)

EVOLUTION

Nature over Nurture

Social insect colonies are divided into different castes with different functions. The environmental determination of caste division has been argued to be essential to the evolution of true sociality in insects. But Volny and Gordon have discovered that the caste system of the red harvester ant is genetically determined. A single queen founds each red harvester ant colony. During the 15 to 20 years of her life, this queen will only use the sperm from her original matings to produce all of the colony's worker and reproductive castes. Sterile workers are the offspring of parents from different lineages, whereas reproductives stem from parents of the same lineage. A viable colony needs both castes, and so to establish a colony the queen must mate with males from more than one lineage. This means that the two lineages will evolve separately by genetic drift while having to remain codependent. A further problem with this type of genetically determined caste system is that it restricts the ability of the colony to change the ratio of workers and reproductives in response to seasonal changes in resources. — CA



Red harvester ants.

Proc. Natl. Acad. Sci. U.S.A. 10.1073/pnas.092066699 (2002).

IMMUNOLOGY

Double Check

Under normal circumstances, self-reactive B cells that escape deletion are prevented from producing autoantibodies through the induction of a functionally inactive state known as anergy. The risk posed by the anergic route of tolerance is evident, however, when these B cells are occasionally reactivated, resulting in autoantibody production and pathology.

Seo *et al.* examined the influence of two T cell populations on an autoantibody response directed at double-stranded DNA (dsDNA), a common target in B cell autoimmunity. In the autoimmune *lpr/lpr* strain of mice, which is prone to developing antibodies to dsDNA, B cells appear to lose tolerance in two distinct stages. In the first, they acquire an altered phenotype, but only generate antibodies during a later second phase. In trying to understand this pattern of autoimmunity, mice expressing a transgene for an antibody to dsDNA were used. B cells from these mice lost their anergic state upon injection of helper T cells. However, co-administration of $CD4^+CD25^+$ regulatory T cells produced only the first "abortive" stage of anergy loss seen in *lpr* mice. This second tier of modulation of the B cell anergy requiring regulation of T cell help may prove an important checkpoint in preventing autoimmunity. — SJS

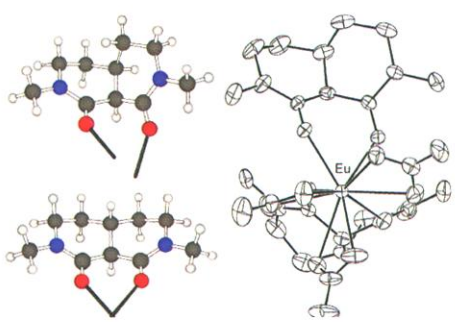
Immunity **16**, 535 (2002).

CHEMISTRY

Designer Bindings

Multidentate ligands are organic molecules that display several functional groups, such as C=O groups, that can be used to bind, or chelate, a transition metal ion. Many "off-the-shelf" ligands commonly used in inorganic chemistry are not actually optimized for chelation and must twist considerably during binding, which weakens the overall interaction.

Lumetta *et al.* examined theoretically the interaction of some commonly used ligands for binding actinide and lanthanide ions, the alklyated malonamides. They then designed a bi-cyclic variant in which the C=O groups are oriented in both the cis and trans conformers so that they favor a lower energy structure that undergoes little reorganization upon binding. In acidic media, this ligand showed an improvement of seven orders of magnitude improvement in the binding constant for Eu^{3+} as compared with several noncyclic malonamides. — PDS



Cis and trans forms of an Eu^{3+} chelator.

J. Am. Chem. Soc. 10.1021/ja025854t (2002).

CREDITS: ALEX WILD/UC DAVIS, (TOP) LUMETTA *ET AL. J. AM. CHEM. SOC.* 10.1021/JA025854T (2002)