GEOSCIENCE

Marine malaise

Biogeosciences **7,** 979–1005 (2010)

As the planet continues to warm, biological productivity in the world's oceans — the generation of organic compounds, mainly through photosynthesis, that supports life and influences Earth's climate system — looks set to fall. Researchers estimate that, by 2100, it could have decreased by as much as 20% relative to pre-industrial times.

Marco Steinacher at the University of Bern and his colleagues used four global coupled carbon-cycle–climate models to project twenty-first-century changes in net marine primary productivity in response to anthropogenic climate change. Assuming a high greenhouse-gas emissions scenario, they found that reduced ocean mixing and circulation led to decreased nutrient availability in the low- and mid-latitude oceans and in the North Atlantic. For parts of the Southern Ocean, where increased sunlight and temperatures could enhance productivity, the study projected a slight increase.

GENETICS

Cross out crossovers

PLoS Biol. **8,** e1000327 (2010)

Near the centre of a chromosome lies the centromere, a region where thin protein fibres attach to pull chromosomes apart during cell division. Unlike other parts of the chromosome, the centromere rarely, if ever, experiences crossover — the exchange of genetic material between two chromosomes of a pair. Yet the centromere is one of the most diverse structures of the genome. Kelly Dawe at the University of Georgia in Athens and his colleagues have discovered one mechanism that may have helped this diversity to arise.

They mapped 238 centromere markers from 93 maize (corn) lines and found no crossing over but observed two instances of gene conversion, in which a short piece of DNA from one chromosome is copied onto another. They also found that, at least in maize, gene conversion occurs frequently, which may explain the high level of centromere diversity.

NEUROSCIENCE

Live-action brain cells

Nature Neurosci. doi:10.1038/nn.2518 (2010)

Monitoring the activity of specific brain cells *in vivo* using fluorescence imaging typically requires animals to be restrained or anaesthetized. A new method that exploits bioluminescence overcomes this limitation — at least in small creatures.

Florian Engert of Harvard University in Cambridge, Massachusetts, and his colleagues created transgenic zebrafish larvae in which selected sets of brain neurons expressed the jellyfish bioluminescent protein aequorin fused with green fluorescent protein, which together respond to changes in neuronal calcium-ion levels. A large-area photodetector above the fishes' tank reported their neuronal activity as they swam freely over several days. Achieving high temporal resolution but limited spatial resolution, the authors identified different classes of neural activities associated with different swimming behaviours.

The method is applicable to animals small enough to move freely within the range of a detector, such as fruitflies and nematode worms, the authors say.

ATMOSPHERIC SCIENCE

Paparazzi pollution

Atmos. Chem. Phys. **10,** 2457–2465 (2010)

During the summer, ship emissions are the primary anthropogenic source of ground-level sulphur pollution in parts of Antarctica. This is due, in large part, to growing tourism (pictured).

Hans Graf of the University of Cambridge, UK, and his group used an existing air-pollution inventory to model sulphur and black-carbon deposition across Antarctica from April 2004 to March 2005. The model includes sulphur emitted by ships, generators and vehicles at scientific base stations, as well as gases from the volcano Mount Erebus.

F. LANTING/CORBIS

The model suggests that summer sulphur emissions from human activities — nearly equal in amount to pollution from Mount Erebus in December 2004 — remain airborne for two weeks before falling out along coastal areas, particularly around bases and shipping lanes. Sulphur is not at dangerous levels in Antarctica, but current deposition patterns may be representative of other, more toxic, man-made pollutants, the researchers say.

JOURNAL CLUB

Michael Brockhurst
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An evolutionary biologist marvels at how species evolve to help each other out.

Mutualistic interactions between species underpin much of nature's biodiversity. These associations range from prolonged and intimate, such as those between nitrogen-fixing bacteria and leguminous plants, to fleeting — visits of pollinating animals to flowers, for example. Despite the wide-ranging importance of mutualisms, there have been few experimental studies on their origins or evolution.

In a fascinating experiment, Kristina Hillesland and David Stahl at the University of Washington in Seattle watched a novel two-species interaction develop from teetering baby steps to a stable, robust mutualism over just 300 generations (K. L. Hillesland and D. A. Stahl *Proc. Natl Acad. Sci. USA* **107,** 2124–2129; 2010).

Grown in the lab with lactate as the sole nutrient source, the bacterium *Desulfovibrio vulgaris* and the archaeon *Methanococcus maripaludis*, which never interact in nature, had to collaborate to survive. *D. vulgaris* fermented lactate to produce acetate, carbon dioxide and hydrogen — a reaction that sustains growth only if the hydrogen concentration is kept low. *M. maripaludis* fulfilled this requirement by consuming hydrogen to reduce carbon dioxide to methane.

Communities were initially poorly adapted to do this, and underwent drastic fluctuations in population size, with some even going extinct. In other communities, however, natural selection ensured that the two processes were optimized, thereby jointly increasing the fitness of both species. Co-evolved communities outperformed their evolutionary ancestors by growing 80% faster and producing 30% more biomass.

The work demonstrates the evolution of a stable multispecies mutualism, enhancing our understanding of how such interactions, so important for biodiversity, come about in nature.

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