Materials science

Spiders forced to spin an unusual yarn

Biomacromolecules doi:10.1021/bm034269x (2004)

Dragline silk, the fibre from which spiders make the scaffolding of their webs, is nature's undisputed high-performance fibre, and unravelling its secrets may help in developing ecologically friendly superfibres. But the forced 'silking' commonly used to obtain silk for experiments may seriously affect the fibres' properties, Christine S. Ortlepp and John M. Gosline warn.

Filming the master spinners in action reveals that abseiling spiders initially fall freely and then slow down by applying friction to their dragline; the data show that the tension on the newly spun silk varies from less than 2% of the thread's breaking load during freefall to about 40% during the slowing-down phase. In contrast, forcibly pulling silk from strapped-down spiders, as occurs in silking, meets with active resistance — the spiders spin at much reduced speeds and apply braking forces that load the silk at up to 60% of its breaking point.

The prolonged braking during forced silking generates local heating. Not only may this induce spiders to abandon silk production, the authors argue, but it may also change the silk's structure. Further, the tension on newly spun silk should affect protein alignment within the thread before it dries, thus also altering its material properties. **Magdalena Helmer**

ALAMY/M. WEINZIERL

Cell biology

Yeast chill out

Mol. Cell **13,** 771–781 (2004)

How do yeast cells stay alive when the temperature plummets to zero? By producing an armoury of protective molecules, according to Olga Kandror and colleagues.

The authors have examined the molecules made by budding yeast (*Saccharomyces cerevisiae*) as the temperature drops to near freezing. They find that, below 10 °C, the cells start to produce enzymes that synthesize large amounts of trehalose — a sugar known to protect organisms against high temperatures and to shield the bacterium *Escherichia coli* from the effects of a sudden drop in temperature. The yeast also generate a set of so-called heat-shock proteins (HSPs), which probably — as they do at high temperatures — bind to damaged proteins and prevent them from unfolding.

To their surprise, Kandror *et al.* also discovered that the hardy cells go on making these proteins and generating trehalose even at 0 °C. New messenger RNAs encoding HSPs and trehalose-synthesizing enzymes are made even though the production of other mRNAs and proteins ceases. The authors also tested yeast that lack trehalose or the gene-transcription factors that make the necessary mRNAs: as expected, these mutants succumbed far more quickly in subzero conditions. **Michael Hopkin**

Vertebrate evolution

Out on a limb

Science **304,** 90–93 (2004)

The advent of limbs for walking on land, and so of the tetrapods, was one of the main events in life's history. The traditional idea is that limbs arose from the fins of fish that were already living, at least in part, on land. But there are indications from the fossil record for the aquatic transition of fins to limbs that had the function of propping up the body in shallow waters.

Neil H. Shubin *et al.* now add to that evidence with their interpretation of a fossil limb bone, a humerus from a creature that lived about 370 million years ago. The authors compared the humerus with the equivalent bones from tetrapod and fish fossils of the same era. They point to its unique features, which, they say, represent an intermediate between fins designed as swimming aids and limbs for walking on land or in water.

Shubin *et al.* conclude that the humerus was not necessarily a component of a limb adapted for locomotion on land. But they argue that important transitions were evidently occurring in fish before the origin of the tetrapod limb with its characteristic elaboration of digits. **David Kramer**

Nanoscale physics

Pure boron tubes

J. Phys. Chem. B **108,** 3967–3969 (2004)

Researchers have already made pure boron nanowires, and theoretical studies indicate that hollow boron nanotubes should be stable; they might even be better conductors of electricity than carbon nanotubes.

Dragos Ciuparu *et al.* now claim to have made the first pure boron nanotubes, by reacting boron trichloride with hydrogen gas at 870 °C. The tubes are single-walled and measure about 3 nanometres in diameter. The reaction relies on a magnesium catalyst loaded onto mesoporous silica. The pores in the silica act as a template for the nanotubes, which grow up to 20 nm out of the catalyst surface.

The authors report that exposure to an electron beam damages the nanotubes, so electron-microscope images of them, taken at low dose, are rather fuzzy. However, the Raman infrared spectrum of the sample is consistent with a tubular structure. A more detailed structural analysis, omitting the electron beam, will follow. **Mark Peplow**

Nanotribology

Slippery secrets revealed

Phys. Rev. Lett. **92,** 126101 (2004)

Explaining graphite's lubricating properties is rather more slippery than conventional wisdom suggests. The usual story is simply that graphitic carbon sheets slide over one another; but Martin Dienwiebel and colleagues show that a phenomenon called 'superlubricity' governs this process.

First proposed in 1990, the effect depends on whether the hexagonal arrays of carbon atoms in each sheet are in registry with one another. Sliding is relatively easy when there is no registry, but if the sheets are rotated until their crystallographic axes line up, they can lock together, with an abrupt increase in lateral friction. That, at least, was the theory. But only now is there good evidence for it.

Dienwiebel *et al.* have designed a new friction-force microscope in which a tungsten tip can move on 'soft' springs in any horizontal direction while being more stiffly confined vertically. The frictional force measured on graphite shows sawtooth-shaped profiles — 'stick–slip' behaviour — in all directions, but the magnitude of the oscillations peaks for substrate orientations 60° apart. This is what the superlubricity hypothesis would predict if, as the researchers think, a flake of graphite becomes attached to the probe tip, so that movements of the tip slide the flake over the substrate. **Philip Ball**