research highlights

TREE GROWTH

Getting back up

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Trees live for decades, centuries or even longer, providing ample time for successful reproduction. However trees must contend with problems that shorter lived plants do not face, such as recovering from falling over. Gerttula *et al.* show that in poplars, a modular control network working through the transcription factor ARBORKNOX2 (ARK2) achieves the response needed to return trees to vertical growth.

When growing trees are laid horizontally they re-orientate by producing different types of wood on their upper and lower sides. While the lower sides of the trunk continues to make conventional wood, the upper produce specialized 'tension' wood capable of exerting additional forces to pull the stem upright. Trees with reduced levels of ARK2 recovered more slowly from being laid down than wild type and much slower than plants overexpressing ARK2. This was not due to any change in the number of tension fibres in the wood, instead those fibres matured more slowly in the reduced ARK2 lines.

By comparing these three lines Gerttula *et al.* were able to uncover some of the details of the trees self-righting behaviour. Gravity perception takes place in specialized amyloplast-containing cells, expressing the auxin transport protein PIN3. The resulting asymmetric distribution of auxin, in conjunction with the gibberellic acid from phloem tissue, leads to ARK2-dependent maturation of tension fibres and so bending of the trees' shoots upwards. *CS*

ECOLOGY

Biocrusts buffer drought

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Biocrusts, comprised of mosses, lichens and cyanobacteria, are common constituents of dryland ecosystems worldwide. An analysis spanning three continents suggests that the conservation of these communities will be key to the maintenance of functional dryland ecosystems under climate change.

Manuel Delgado-Baquerizo and colleagues assessed the ability of moss-dominated biocrusts to regulate soil nutrient and carbon cycling across aridity gradients in the US, Spain and Australia, using measurements of soil carbon, nitrogen and phosphorus levels, together with microbial extracellular enzyme activities. Soils underlying biocrust canopies had greater multifunctionality, that is they stored and cycled more carbon and nutrients, than bare soils in arid and semi-arid regions, but not in more-humid regions. As a result the beneficial effects of biocrusts on soil multifunctionality increased with aridity. Structural equation modelling suggests that the rise in the beneficial effects of biocrusts with aridity can be attributed to an increase in soil microbial abundance, and a reduction in plant cover.

The researchers suggest that biocrusts could prove crucial to the sustainability of dryland ecosystems, which are projected to become increasingly arid over the coming century. *AA*

CROP DOMESTICATION

Baked beans

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Fava or broad beans (*Vicia faba*) are a widely grown crop and the third most cultivated legume after soybean and pea. As well as being an excellent accompaniment to a fine Chianti they are particularly efficient nitrogen fixers. However, the origin of their domestication is unclear. By using carbon isotope analysis of archaeological samples Caracuta *et al.* have shown that fava was already a significant crop in the southern Levant over ten thousand years ago.

Fava bean grains have been found in abundance at three Neolithic sites in the Galilee region of northern Israel. However fava bean remains are rare or absent at other sites of a similar age in Israel, Syria and Turkey. These grains had been charred by fire complicating attempts at carbon dating. Therefore the authors first took modern fava beans and charred them at various temperatures to observe how the size of grains and their carbon isotope composition was affected.

With this modern data as calibration the researchers were able to use radiocarbon dating to determine that the earliest beans are 10,200 years old, while stable carbon isotope analysis showed that they had been grown at a time of relative water abundance. The success of this initial domestication probably relied on farmers' subsequent selection of seeds able to grow in the dryer conditions that later ensued. *CS*

EVOLUTION

Symbiotic beginnings

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Two billion years ago, oxygenic photosynthesis appeared in cyanobacteria. Another billion years later, endosymbiosis produced the first eukaryotic marine plants. The next step happened 450 million years ago, during the Palaeozoic era when plants began growing on land, an event that had a considerable impact on the history of life.

Jean-Michel Ané, Pierre-Marc Delaux and colleagues performed a comprehensive phylogenetic analysis of hundreds of algae and early-diverging land plants, focusing on the symbiotic signalling pathway. Most land plants today form a beneficial arbuscular mycorrhizal association with fungi, allowing them to increase their mineral nutrient and water uptake. The result was surprising: algae were prepared for the transition to land. While still in water, they had already developed parts of the molecular pathway allowing them to associate with fungi — which were already on land — to form the symbiosis necessary for their survival.

Key signalling components such as a calcium-and-calmodulin-dependent kinase were present in early chlorophyte algae, the gradual functional evolution of which was assessed by complementation of a *Medicago truncatula* mutant. Other downstream components of the symbiotic pathway evolved after land colonization. These discoveries fit well with the scant fossil record, and expose the successful innovations that allowed plants to thrive outside of water. *GT*

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