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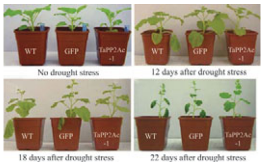
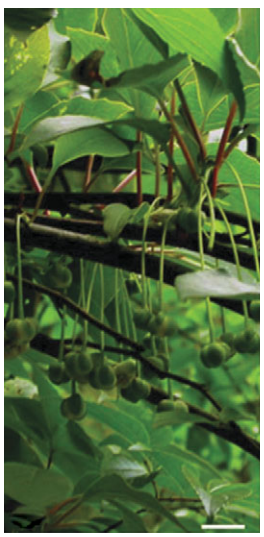
John Bryant takes a closer look at some of this month's Original Articles



PP2 participates in protection

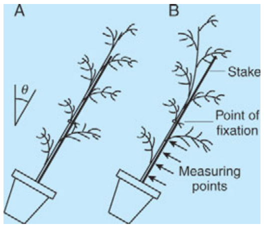
Higher organisms, including plants, devote a surprisingly large proportion of their genome to encoding enzymes that modify other proteins by adding or removing phosphate groups. Some of these reactions are involved in regulating enzyme activity; others are involved in signalling pathways, responding to developmental and/or environmental cues, and it is one of these that is discussed here. Of the multiplicity of protein phosphatases, **Xu *et al.* (Beijing, China, pp. 439–450)** have focused on PP2A. This specifically removes phosphate from serine or threonine residues (and of course there are protein kinases that specifically transfer phosphate from ATP to these residues). A gene encoding the catalytic subunit of PP2A in wheat, *Triticum aestivum* (*TaPP2Ac-1*) had been previously identified as an incomplete cDNA (or EST, expressed sequence tag) in a library from seedlings of a drought-tolerant cultivar exposed to water deficit (−0.5 MPa) for 12 h. The authors have now obtained a full-length cDNA and used it as a probe to study the time-course of gene expression at the same water potential. Expression peaks 6–12 h after the start of water deficit and then declines (but not to baseline levels). The question then is whether this response has any role in the increased drought tolerance of this cultivar. To test this possibility, the gene was inserted into a binary vector based on the bipartite genome of an RNA virus and delivered to tobacco leaves by *Agrobacterium tumefaciens*. This vector system allowed high levels of expression, as demonstrated by detection of the *TaPP2Ac-1* mRNA and the protein itself. The transgenic plants showed a significantly increased drought tolerance, as shown by increased ability to retain water and to maintain relative water content, increased water use efficiency and greater leaf cell-membrane stability during drought conditions. Thus, although *TaPP2Ac-1* is the first of the PP2A gene family to be isolated from wheat, there is already strong evidence for its involvement in responses to drought.



ANITA and the neater pollen eater

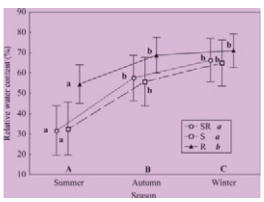
The 'ANITA grade' of extant plant families is a group that branched very early from the main angiosperm lineage. One feature of the early evolution of flowering plants that is widely accepted is the importance of mutualistic interactions with insects; it is one of those interactions that has been studied by **Yuan *et al.* (Beijing, China and New Orleans, USA; pp. 451–460)**. Since the Schisandraceae is an ANITA grade family with a little-known pollination biology, the authors have focused on *Schisandra henryi*. This species is dioecious but the male and female flowers, hanging on slender pedicels, are very similar. Both male and female flowers lack fragrance and no potentially fragrant molecules were detected by GCMS. Furthermore, no nectar is produced and the flowers are not thermogenic. It is therefore likely that pollinators are attracted by visual cues alone. The small size of the floral orifice prevents most insects entering the flowers. The sole pollinators are females of a gall midge in the genus *Megommata*. Their reward for visiting male flowers is pollen, some of which is eaten by the gall midges. However, female flowers, which the female *Megommata* also visit, obviously produce no pollen. Essentially, this has every appearance of a deception strategy by the plant: the very similar flower appearance and greater abundance of male flowers (outnumbering female flowers by at least 3 : 1) means that insects will visit female flowers 'by mistake' and thus transfer pollen. This study has thus yielded several novel results. The *Megommata* species was previously unknown; it is the only predacious gall midge known to eat pollen. Restriction of pollination to a single species contrasts with more generalist pollination strategies in other members of the ANITA grade. Although deceit is quite widespread, it seems likely to have appeared early in angiosperm evolution.

Continued overleaf



Inclined to take the strain

As students, many of us learned about the negative gravitropism of shoots by laying a potted plant on its side and then observing the differential growth that restores the growing axis to the vertical. However, for woody plants, the problem is not so easily solved because radial secondary growth from the vascular cambium leads to the formation of a thick, rigid secondary xylem, as discussed by **Yamashita *et al*. (Nagoya, Japan, pp. 487–493)**. Nevertheless, woody plants do have some capacity for righting themselves if a stem becomes inclined away from the vertical and this is achieved by mechanical bending. To investigate this, the authors used 2-year-old pot-grown saplings of the gymnosperm *Cryptomeria japonica*. These were inclined at angles of up to 50° from vertical; growth and biomechanical responses were monitored. Gymnosperms respond to being away from vertical by forming compression wood on the underside of the stem. This is characterized in particular by thicker secondary walls and higher lignin content. The authors used a strain gauge to measure the released strain of the compression wood: the compression wood was 'released' from its integration in the stem by making incisions through the new growth. A positive reading on the strain gauge indicated compressive growth stress. The thickness of the compression wood and the magnitude of the longitudinal released strain both increased up to approx. 30° inclination but then plateaued. The same was true of wall thickness and lignin content of the compression-growth layer. These data, and especially those on longitudinal released strain, correlated very closely with the bending moment, which again increased up to a 30° inclination. It is concluded that in gymnosperms, as in angiosperms, the development of reaction wood forces the stem back towards the vertical. An angle of 30° is rather critical; at inclinations greater than this, righting the stem takes somewhat longer.



Seeds, sprouts and saving water – strategies for surviving fire

Fires are a normal part of several ecosystems in many of the warmer parts of the world. However, the ground does not remain bare for long after the fire because many species are adapted to living in these fire-prone habitats. In Europe, this is typified by the regeneration of shrubland in the Mediterranean region, as described by **Saura-Mas and Lloret (Barcelona, Spain, pp. 545–554)**. They focused on a region of coastal shrubland in north-east Spain that experiences a sub-humid Mediterranean climate. The authors note three main strategies for regeneration after fire: re-sprouters – these are able to re-grow from organs that are protected from the heat; seeders – these have heat-tolerant seeds that germinate after fire; and re-sprouter/seeders – these make use of both mechanisms. The question asked was whether the shrubs that fall into these three categories show differences in their physiology under normal conditions. Thirty woody plant species typical of the habitat were classified according to their regeneration strategy and this was related to plant phylogeny: plants from the same family were very likely to exhibit the same regeneration strategy, indicating that some adaptive features go back a long way in the evolution of these groups. Several indicators of water and nutrient physiology, such as leaf relative water content (RWC) and leaf dry matter content (LDMC), were measured from spring through to winter and there were clear correlations between these indicators and regeneration strategy. Thus, leaf RWC was always higher in re-sprouters, suggesting a greater ability to reduce water loss and maintain water content. By contrast, the seeders appear more drought tolerant. Re-sprouters also had a greater LDMC, attributed to 'a more efficient conservation of nutrients'. Interestingly, the re-sprouter/seeders resembled the seeders rather than the re-sprouters in respect of both these variables. The plant community is thus moulded both by climate and by sporadic factors such as fire.

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