

# ContentSelect

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

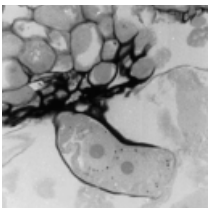
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## Taking nitrogen with a pinch of salt

As highlighted in last month's *Annals of Botany*, the formation and function of nitrogen-fixing nodules in legumes relies on a subtle and complex interplay between host and symbiont, an interplay that is readily disrupted by certain abiotic stresses. Salinity, for example, inhibits nodule formation (even though the *Rhizobium* can still infect the plant), disrupts the development of nitrogen-fixing capability in differentiating nodules and reduces N<sub>2</sub>-fixation in fully formed nodules. This is bad news for anyone wishing to grow legumes in arid or semi-arid regions where saline and/or alkaline soils may be widespread. However, one grain legume, *Cicer arietinum* (chick pea), is widely grown in semi-arid regions and it is important to try to improve its performance under stressful conditions. An international team (**Rao *et al.*, pp. 563–570**) has studied nodule formation and the N<sub>2</sub>-fixing capability of nodules in a range of *C. arietinum* cultivars in field- and laboratory-grown plants. The cultivars differed significantly in their nodulation and N<sub>2</sub>-fixation activity under stress, although in all cultivars nodulation and N<sub>2</sub>-fixation were reduced significantly as salinity increased. However, one particular cultivar stood out as performing much better than the others in saline conditions. Furthermore, when the cultivars were compared under control conditions, it was apparent that cultivar performance under stress was correlated with nodulation capacity in normal soils. But what of the other partner, the *Rhizobium* symbiont? Earlier authors had shown that the bacterium is, in general, more salt-tolerant than the host and the data in this paper show that the bacterium does not feature as an important factor in the effects of salinity on nodulation. The authors conclude that '... selection for improved nitrogen fixation should proceed by first screening ... to identify genotypes with the best available nodulation and grain yield characteristics under salt stress'. Good advice which should be heeded.

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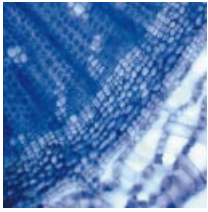


## Pollination up a gum tree

There has been extensive progress in understanding the molecular basis of the self-incompatibility mechanisms that prevent the pollen tube from growing down the style. However, this is only part of the story. Styler mechanisms operate early in pollination/fertilization but it is now apparent that some self-incompatibility mechanisms operate much later. In pre-zygotic mechanisms, the pollen tube may grow as far as the ovule but not penetrate it, or penetration may be achieved without fertilization. Even later are post-zygotic mechanisms that allow fertilization, but in which the zygote fails to develop into a functional embryo. This brings us to the gum tree, or more specifically, to *Eucalyptus globulus*, grown widely as a source of wood-pulp. This species shows much individual variation in its breeding system. Some individuals are obligately outbreeding whereas others are, to varying degrees, self-compatible. This poses problems for the grower (who prefers outbred seed in order to avoid inbreeding depression) and for the breeder. So, an Australian team (**Pound *et al.*, pp. 613–620**) has investigated pollination, fertilization and embryo growth in self-incompatible and partly self-compatible individual trees. For researchers who work with model herbaceous species, the time between pollination and the completion of fertilization in trees (and *Eucalyptus* is certainly not atypical) may be surprising: 'Fertilization had taken place at 4 weeks after pollination ... By 6 weeks ... a few zygotes were starting to divide.' Arabidopsis can give a very biased view of the plant kingdom! A further clear feature is that incompatibility mechanisms operate at late pre-zygotic and post-zygotic stages. The authors have also established criteria, based on ovule size at 6–8 weeks, for determining whether cross- or self-pollination has occurred. This will be very useful for growers and breeders. However, for me, a further major question is raised: how do these late-operating incompatibility mechanisms work at the molecular level?

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### Coming up for air

Plants that are subject to flooding or which grow partially submerged often develop aerenchyma — air-conducting channels formed in the cortex — in order to supply air to the submerged parts of the plant. However, aerenchyma formation is problematic in plants that undergo secondary growth. In secondary growth the tissues in which aerenchyma normally forms are often lost, depriving the plant of a route for transporting oxygen to submerged organs. It has been widely suggested that phellem, a corky outer layer derived from the cork cambium (phellogen) may function as aerenchyma, but until now no-one had tested that hypothesis. However, this deficiency has been remedied by a group at Guelph University (**Stevens *et al.*, pp. 621–625**). Laboratory-grown plants of *Lythrum salicaria* (purple loosestrife, a familiar waterside plant in temperate regions), were subjected to immersion of their roots and the lower parts of their shoots. The phellem was ringed at the stem base, breaking the continuity of the tissue. Gas exchange and growth were monitored during continued immersion. The results were clear: ringing the phellem reduced markedly the oxygen content of roots but not of shoots. This suggests that the phellem does indeed have a role in root aeration. However, the fact that the roots still contained significant amounts of oxygen suggests that there may also be other routes for air conduction. Another interesting feature is that ringed plants showed a reduced root biomass and an increased shoot biomass, the latter being very obvious in increased plant height. Waterside and amphibious plants that become completely submerged often respond with rapid shoot elongation and thus regain contact with the air. However, in these experiments, the shoots were never out of contact with the air so the function of this shoot growth is not clear. Further experimentation is obviously needed.



### Elm embryos: early opportunity for ease of induction

A key step in plant genetic manipulation is regeneration of plants from the genetically transformed cells. In some instances this may be straightforward, but many species present a real challenge. **Corredoira and colleagues at the Galician Agrobiological Research Institute (pp. 637–644)** discuss the possibility of genetic manipulation of elm (*Ulmus glabra* and *U. minor*), in relation to the transfer of resistance to Dutch elm disease. The loss to this disease of much of the European elm population is well documented. However, despite much intensive research effort, it remains a major practical problem. Therefore the authors have sought to develop a method for growth of an elm tissue culture with the potential for induction of somatic embryos. As starting material they used normal zygotic embryos from which callus cultures were established. Induction of somatic embryogenesis was then attempted by manipulation of the hormone content of the medium. Their data show that there is a short period during the development of the zygotic embryo in which it is possible to establish embryogenic cultures. This occurs at the ‘cotyledonary stage’, after the embryos have developed bilateral symmetry, but before the deposition of storage reserves. These results illustrate a feature widely seen in plant tissue culture: the developmental/physiological status of the tissue used to initiate a culture can influence the subsequent potential of that culture. In this instance, it may be significant that the phase of reserve deposition is, in many dicots, associated with a peak of ABA content in the embryo. Possibly this induces changes that depress the embryogenic potential of the callus culture. So, selection of embryos at an appropriate stage is the key to success, but, as the authors point out, this is only the beginning. Subsequent performance of the embryos must be optimized before growth of trees from genetically modified callus becomes a real possibility.

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