

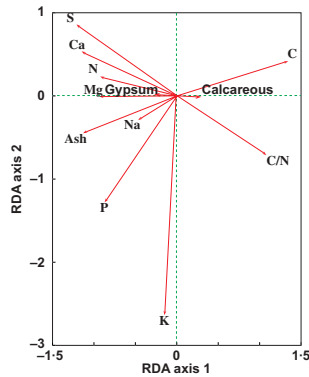
Networking – a turn-on for some genes, a turn-off for others

Although we sometimes speak about signalling pathways, it is usually more appropriate to speak of signalling networks. This is well illustrated by the work of **Ogawa *et al.* (Tokyo, Iwate and Saitama, Japan, pp. 239–244)**, which focuses on two genes in *Arabidopsis thaliana*. The first is *APETALA2* (*AP2*), which is an A gene in the well-established ABC model for floral homeotic genes. The *AP2* protein also contains two ethylene-responsive element binding protein domains, suggesting that in addition to acting as a transcription factor in flower formation it also regulates expression of at least some *ethylene-responsive factor* (*ERF*) genes. The other gene is an *ERF* gene, *AtEBP*, encoding a transcriptional activator, ethylene-responsive element binding protein. The gene is regulated by ethylene via the *EIN2* protein but it may also be regulated by the *AP2* transcription factor. The authors have therefore carried out a comprehensive series of experiments to test the interactions of the two genes. In the *ap2-5* mutation, the effectiveness of the *AP2* transcription factor is much reduced; this is clearly seen in flower development. In leaves, stems and flowers, the *ap2-5* mutants also show increased levels of *AtEBP* mRNA and of *AtERF1* (another *ERF* gene) mRNA. Thus, wild-type *AP2* protein acts as a negative transcription factor for at least two *ERF* genes. Even more intriguingly, transcription of *AP2* is increased in *ap2-5* mutants: wild-type *AP2* down-regulating its own gene. *AtEBP* also affects expression of *AP2*: in transgenic lines over-expressing the *AtEBP* gene, the amount of *AP2* mRNA was increased (as was that of *AtERF1*). Thus, *AtEBP* is a positive regulator of *AP2* gene expression. Based on these and other results in the paper, it is clear that the genes interact with each other in some ethylene responses, in flowering and in other aspects of plant development – a clear example of a signalling network.



Acid and ammonium provide potent brew for tea

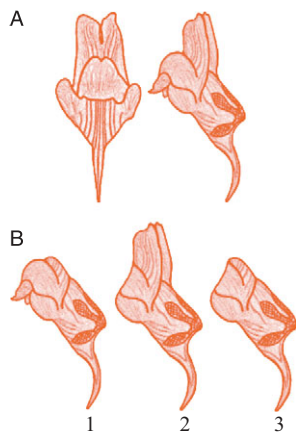
Writing this just after breakfast, I am conscious of the importance of drinking tea at the start of my day. I am also interested that, despite it being a major commodity, there is still much that we do not know about the basic physiology of the tea (*Camellia sinensis*) plant. Thus, as stated by **Ruan *et al.* (Kiel, Germany, Hangzhou, China, and Poznań, Poland, pp. 301–310)**, *C. sinensis* is considered to be an acid-tolerant plant that prefers NH_4^+ for N nutrition. However, little is known about the interaction between the acidity of the growth medium and the preferred form of N. The authors grew plants hydroponically at three different acidic pHs and supplied N as NH_4^+ or NO_3^- or both. At all three pHs, plants took up NH_4^+ faster than NO_3^- and this differential was greater when the two were supplied together. Plants supplied with only NO_3^- had a low relative growth rate and were markedly N-deficient. Indeed the authors describe the N levels in leaves of NO_3^- -fed plants as close to critical. Plants supplied with NH_4^+ showed elevated levels of the key enzyme glutamine synthetase and absorbed N very efficiently. The most favourable pH for both N uptake and biomass production was 5.0 with either N source. The drop-off either side of this peak was much more marked at pH 6.0 than at 4.0, particularly with NO_3^- . Indeed, with NH_4^+ as the N source, there was no difference in root growth rates between pH 5.0 and 4.0. Several other aspects of physiology and biochemistry were unaffected by root-zone pH, including glutamine synthetase activity and concentrations of free sugars and amino acids. In addition to being helpful in the husbandry of tea plants (and hopefully to the quality of my breakfast beverage), these data may, as the authors suggest, reflect the ecology of the crop's wild ancestors in south-west China.



Poor competitors find refuge amongst specialists

Until recently I knew gypsum, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, mainly as a component of some paints and as an insulating material in the building industry. It certainly does not appear to be a very promising substrate for plant growth. Thus, **Palacio *et al.* (Xaragoza and Móstoles, Spain and St Paul, MN, USA, pp. 333–343)** state that gypsum soils often form a hard surface crust that makes germination difficult; they tend to be mechanically unstable with unpredictable water relations, while their basic chemistry includes not only excesses of Ca and S, but also of Mg. Although these features may compromise plant survival, there are plants that grow and even thrive on gypsum soils. The authors suggest that these fall into two categories: gypsovags, gypsum-tolerant plants that find refuge in this stressful environment as a strategy for avoiding competition; and true gypsum specialists or gypsophiles that are more or less confined to gypsum soils. Based

on their work in Spain, the authors subdivide the latter into regionally dominant species and narrowly distributed endemics. They have carried out a thorough chemical analysis, in relation to soil composition, of plants representing all three groups and have subjected the data to detailed statistical analyses. It is clear that in terms of chemical composition, regionally dominant gypsophiles differ from gypsovags. In particular, the former are able to accumulate nutrients that are scarce in gypsum soils, in addition to being tolerant of higher than normal concentrations of Ca and especially of S and Mg. Gypsovags, despite their ability to grow in these soils, do not show either of these features (implying incidentally that they possess mechanisms for excluding the more toxic elements). Intriguingly, the narrowly distributed gypsophiles are similar to the gypsovags. This work has thus provided significant information on a somewhat neglected aspect of plant biodiversity. This is important both for conservation of specialized floristic assemblages and for plant breeding, the latter in relation to growing crops on more marginal land.



The unkindest cut?

In discussion of plant–animal relations, a number of topics come readily to mind. One is pollination and another is herbivory, where the focus is most often on leaves and shoots. Further, the interaction between these two may be important, as shown by **Sánchez-Lafuente at Seville, Spain (pp. 355–364)**. The author worked with *Linaria linacina*, a member of the Scrophulariaceae with complex flowers, and asked whether flower herbivory affects pollination. This, in turn, raises the question of which components of floral morphology are important in attracting pollinators. The author observed floral herbivory in the field and then mimicked the action of herbivores by removing parts of the corolla. From his extensive study, we focus here on just three features. First, removal of the upper lip of the corolla led to a only a slight reduction in the frequency of visitation by pollinators, whereas removal of the lower lip caused nearly a 50 % reduction in the number of visits; removing both lips had a similar effect to removing the lower lip. The lower lip of the corolla is thus important in attracting

pollinators. Secondly, in terms of success of those visits that did occur, results varied between the three main pollinating species. However, in general, removal of either lip or both reduced markedly the likelihood that a visit would be successful. Finally, and as might be expected, different treatments did lead to differences in fruit set. Plants in which the upper lip was removed showed a similar level of fruit set to controls. Removal of just the lower lip or of both lips reduced significantly the proportion of flowers that set fruit, but the number of seeds per fruit was not affected. This study, especially when the author's results on fruit predation are also considered, gives an insight into the complex web of biotic factors that affect plant reproduction.

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