RAMP speeds up metallic traffic

Investigations of ‘model’ plants such as *Arabidopsis thaliana* give us a lot of good information about plant genetics, biochemistry and physiology. Despite this it is often necessary to carry out similar investigations with specific crop plants in relation to specific local situations. An example is provided by the work of *Xiao et al. at Beijing (pp. 881–889)*, focusing on a strongly cold-tolerant apple species, *Malus baccata*, widely used as a rootstock in north China. Iron deficiency is a widespread problem, especially for trees grown on calcareous soils. The authors have therefore investigated at the molecular genetic level the trafficking of Fe together with Mn and Cd. NRAMPs (natural resistance-associated macrophage proteins) are highly conserved proteins, present in both prokaryotes and eukaryotes, that are implicated in the transport of metal ions. Based on sequence data from NRAMPs in different plant species, the authors have used RT–PCR and RACE to isolate a full-length cDNA encoding an NRAMP protein in *M. baccata*. Southern blotting showed that the *MbNRAMP1* gene exists as a single copy in the *M. baccata* genome. The gene was most strongly expressed in roots and the level of expression increased under Fe deficiency, as indicated by northern blots. A direct demonstration of the role of *MbNRAMP1* in trafficking of metal ions was achieved by transferring the gene into yeast mutants deficient for Fe and Mn uptake. Both strains were rescued by the *MbNRAMP1* gene, indicating that uptake of both ions had been restored. Expression of *MbNRAMP1* also increased Cd uptake in yeast, rendering the cells more sensitive to Cd toxicity. As in *M. baccata* itself, expression was strongly influenced by iron status. Further, evidence obtained with GFP-tagged *MbNRAMP* protein suggests that yeast cells can also regulate the subcellular location of the protein in response to changes in iron status.

Bitter harvest of ancient aubergines

Information about domestication and early breeding of crop plants comes from many sources, including archaeology, genetics, ethno-botany and agriculture. Such sources have, for example, given us a picture of domestication of cereals in the fertile crescent some 10,000 years ago. However, for many non-staple crops, domestication was much more recent (and indeed is still in progress), giving us further sources of information on the process. These sources include fine arts (e.g. Janick J, Paris HS. 2006. The Cucurbit images (1515–1518) of the Villa Farnesina, Rome. *Annals of Botany* 97: 165–176) and literature, the latter typified by the work of *Wang et al. (Beijing and London, pp. 891–897)*. Their focus is on *Solanum melongena* (aubergine/eggplant), an important cash crop in the family Solanaceae. This is believed to have originated from a sub-tropical wild species, *S. incanum*, with domestication centred on south-east Asia; however, both the documentary evidence and the genomic data are fragmentary. For example, DNA sequence analyses have not included Chinese eggplant cultivars nor the wild *Solanum* species of that region. The authors have taken advantage of the vast and extensively archived range of ancient Chinese literature, including botanical books, encyclopaedias and non-scientific literature. Their detailed and painstaking analysis has come up with the earliest reliably documented record of eggplant cultivation as 59 BC in the Chengdu province, thus challenging the accepted view. According to descriptions at the time, the fruits were very small and round and tasted very bitter (described as ‘not palatable’); weedy species present today in the same region also have small, very bitter fruits. The literature provides evidence for selective breeding from the 7th century AD onward, leading to much sweeter and larger fruits of a variety of shapes. For the latter two traits we now have a clear understanding of their genetic basis. Nevertheless, a question remains. Why was such a plant with small and very bitter fruit, unsuitable for any modern-day moussaka, cultivated in the first instance? Did it perhaps have a use in ancient medicine?
**Populations prove predominant in making sense of scents**

In my lectures on plant metabolism I have often pointed out the importance of reactions and pathways that are common to the synthesis of several different classes of compound. An example is the shikimic acid pathway, leading to compounds as diverse as aromatic amino acids, anthocyanins and the aromatic components of plant scents. It is this common use of the shikimate pathway that has led Majetic et al. at Pittsburgh, Colombia (SC) and Cornell (pp. 911–922) to propose that in *Hesperis matronalis*, polymorphisms in anthocyanin-based floral pigments may be linked to variations in floral scents. They studied five populations located in southern Canada, north-west Pennsylvania and northern Virginia. In each population, scent composition and emission rates were analysed by GC-MS for 10 purple and 10 white individuals. This analysis revealed the presence of 39 volatile compounds, a mixture of aromatics and terpenoids, all of which were scored as present or absent for each plant. Statistical analysis showed that the five populations differed significantly from each other in terms of scent composition and emission rates. Within each population the means represented quite wide variation in both these features, but this was not correlated with colour polymorphism. There were no differences, either for aromatics or for terpenoids, between the purple and white morphs. Thus, the hypothesis that shared biochemistry leads to a linkage between colour and scent must be rejected. Differences between plants are thus most likely based on population-level phenomena. In small, recently established populations a founder effect may be important, although if it is, then the intra-population variation suggests multiple introductions (i.e. of several different genotypes) into the same area. Other possibilities include differences in pollinator species and their preferences, and differences in stress factors, including herbivores and pathogens. As the authors themselves suggest, experiments with known biochemical mutants in ecologically relevant environments are likely to provide valuable further information.

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**Defence budget allocations do not limit growth**

Condensed tannins (CTs) are amongst the range of plant defence chemicals. Some CTs have antibiotic properties and as a class they are known to deter herbivores. However, it is not clear whether they are synthesized constitutively or are induced by enemy attack. Häring et al. (Zurich, pp. 979–987) have used *Onobrychis viciifolia* as a model plant in the study of the role of specific elicitors in the synthesis of CTs. Elicitors are specific chemicals that enable a plant to detect enemy attack and can thus be used to mimic such attacks in the absence of the invading organism. Plants were grown at 0.0027, 0.075, 0.67 or 2.0 mM P (minimal to supra-optimal); growth parameters and foliar CT concentrations were measured. Plants were then given one of three treatments: control, sterile mechanical wounding and sterile mechanical wounding plus the application of one of three specific elicitors. The fungal elicitor was a solution of hydrolysed chitin plus a chemically uncharacterized compound from *Penicillium chrysogenum*. The bacterial elicitor was a suspension of lyophilized *Micrococcus lysodeikticus* in a solution of peptides derived from bacterial flagellin and from a prokaryotic elongation factor. The insect elicitor was the saliva of *Spodoptera littoralis* caterpillars, previously raised on *Onobrychis viciifolia* plants. Relative growth rates were highest at 0.67 mM P. Foliar CTs were synthesized at all P concentrations, but the concentrations were negatively correlated with P concentration. Mechanical wounding led to a decrease in CT concentrations. Application of fungal and bacterial elicitors caused maintenance of CTs at control concentrations whereas the insect elicitor induced significantly higher CT concentrations. Thus, the data provide evidence for both constitutive and inducible synthesis in the same plant, with the strength of induction depending on which elicitor is present. Furthermore, growth was unaffected by either mechanical wounding or by elicitor application, indicating an absence of trade-offs between CT synthesis.

Professor J. A. Bryant  
University of Exeter, UK  
E-mail j.a.bryant@exeter.ac.uk