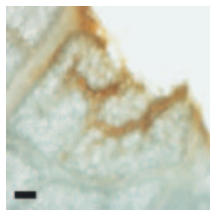


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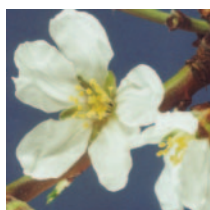
John Bryant takes a closer look at some of this month's Original Articles

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## Leaving a nasty taste in the mouth—but perhaps not nasty enough

In the millions of years in which plants and insects have co-existed many different types of interaction have evolved. Many of these interactions involve some sort of mutual benefit. However, others are distinctly one-sided, such as attracting pollinators by deceit or insects using plants as food. In response to herbivory, many plants have evolved defence mechanisms including the synthesis of anti-feedant chemicals. On the other hand, many herbivorous insects have methods of dealing with anti-feedants and some even accumulate them as their own defence against predators. Here we focus on the work of **Ruuhola and Yang (Turku, Finland, pp. 29–37)** on the herbivory by larvae of the autumnal moth (*Epirrita autumnata*) of mountain birch (*Betula pubescens* subsp. *czerepanovii*) in Finland. Fourth-instar larvae were allowed to feed on leaves on trees in the wild and on branches in the laboratory; enzyme activities involved in plant defences were assayed. Feeding induced increases in activities of polyphenol oxidases and guaiacol peroxidase. Catalase activity, by contrast, decreased. In laboratory experiments, the most rapid response observed was the accumulation of the reactive oxygen species  $H_2O_2$  around the wound site. This is thought by the authors to be involved in the induction of the oxidase and peroxidase activities. Overall, this looks like a classic anti-feedant response with the added dimension that  $H_2O_2$  may inhibit the entry of opportunistic pathogens. However, there is more to this situation. Firstly, the larvae clearly have some ability to overcome the anti-feedant 'environment'. Indeed, in years of heavy infestation, extensive defoliation and even death of trees occurs. Further, in more normal years there is evidence of induced resistance to herbivory occurring in the following season. This implies some sort of systemic response, perhaps mediated initially by the diffusion of  $H_2O_2$ . Investigation of this will surely be a fruitful topic for further research.

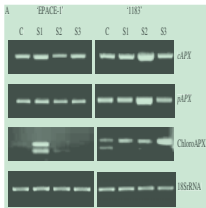


## Late arrivals are welcome in the almond orchard

An almond orchard in full bloom is indeed a pretty sight, one that for me is associated with spring holidays in the Mediterranean region. However, it is a sad fact for almond growers that, as pointed out by **Yi et al., Athens, Georgia and Bakersfield, California, USA (pp. 57–63)**, percentage fruit set from those flowers may be as low as 30 %. What is it that limits fruit set in almond? One clue is that almond is almost completely self-incompatible and therefore requires cross-pollination. Following this up, the authors examined the effectiveness of pollination in relation to the developmental stage of the flower receiving the non-self pollen. Flowers were examined by light microscopy and by SEM; pollinations with non-self pollen were done by hand over the period from flower opening through to petal abscission. During the life of an individual flower, the stigmatic papillae elongate and the amount of stigmatic exudate increases. Intuitively we may expect that these changes are associated with increased receptivity of the stigma and the authors' observations show that expectation to be correct. However, what is unexpected is the timing of this maximum receptivity: it occurs late in the life of the flower, after the flower is fully open, and receptivity continues even after petals start to abscind and fall off. There is no loss of ovule viability in this period since almond is one of those species in which ovule maturation occurs only after successful pollination. At the most receptive stages, pollen germination was at a maximum and pollen tube growth was fastest. In the hand-pollination experiments, maximum fruit set varied between 44 and 75 % in different cultivars, significantly higher than that usually obtained in commercial orchards. The authors suggest that almond growers should bring honeybee hives into the orchards throughout the flowering period in order to maximize nut production—a practical step that, fortunately, will not decrease the aesthetic appeal of almond orchards in bloom.

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*Continued overleaf*



### Profiles of potentially protective peroxidases

One effect of water deficit is the production of reactive oxygen species including  $H_2O_2$ , which the plant is able to remove through the activity of peroxidase enzymes. In green leaves, the major detoxifying peroxidase is ascorbate peroxidase (APX). **D’Arcy-Lameta *et al.*, Paris, France (pp. 133–140)** report their investigation of APX in drought-tolerant and non-tolerant varieties of cowpea (*Vigna unguiculata*). Plants were exposed to progressive drought by withholding water.

Baseline activity of APX was much higher in the drought-tolerant cultivar than the non-tolerant variety, and did not increase significantly during water deficit. However, in the non-tolerant variety, activity increased as leaf water potential fell to  $-1.5$  MPa but declined to control levels as water deficit became more severe. Cloning and sequencing of APX cDNAs revealed the existence of four genes, identified as encoding isoenzymes in the cytosol, peroxisomes and chloroplasts (two genes: one stromal and one in the thylakoids). Amounts of mRNA in leaves exposed to progressive drought indicated an up-regulation of the genes encoding the cytosolic and peroxisomal isoenzymes in the non-tolerant but not the tolerant variety, in concordance with the data on total APX activity. However, expression patterns of the chloroplast isoenzymes were more complex. In the tolerant variety, mRNAs for stromal and thylakoid forms were present in very low amounts in control plants; there was a dramatic increase in abundance in the early stages of drought, peaking at approx. 1.0 MPa, after which both declined to almost undetectable levels. In the non-tolerant variety both these genes were expressed significantly under control conditions. The onset of drought led to a major reduction in the mRNA encoding the thylakoid form but expression of the stromal form increased with increasing severity of water deficit. These data on mRNA populations thus provide clues that assays of total enzyme activity may hide more subtle changes in individual cell compartments.



### Pollen collection does not guarantee pollen delivery

The need for a pollen transfer agent is clearly a factor that can limit the fertility of self-incompatible flowering plant species. On several previous occasions we have discussed some of the more spectacular pollination mechanisms. However there is still much to be discovered about more ‘conventional’ pollination systems. This is well illustrated by the very thorough research carried out by **Adler and Irvin, University of Georgia, USA (pp. 141–150)** using the bee-pollinated perennial vine, *Gelsemium sempervivens*. There are two floral morphs: thrum (anthers protrude beyond the corolla tube, stigma concealed within the tube) and pin (stigma protrudes, anthers are within the tube). The authors observed visits from several types of bee, and focused their investigation on five of these: *Bombus*, *Habropoda*, *Osmia*, *Apis* and *Xylocopa*. The latter often ‘robs’ flowers by collecting nectar through slits made in the base of the corolla. Capture of bees followed by counting *Gelsemium* pollen grains revealed a  $>10$ -fold range between species in the amount of pollen carried. Then came an elegantly designed study of pollen transfer (or transfer of fluorescent particles as a pollen surrogate). Captured bees were carefully wiped clean of adhering grains and then allowed to forage for pollen/fluorescent particles, after which they were offered emasculated flowers as targets for pollen/particle transfer. These investigations showed clearly that the amount of pollen transferred to a receptive stigma was not tightly related to the amount of pollen collected: the bee species carrying the most pollen were not necessarily the most effective pollinators. Overall, *Xylocopa* was the least effective pollinator, even when it did not rob the flowers; *Bombus*, *Osmia* and *Habropoda* were the most effective. Surprisingly, floral morphology did not affect pollination efficiency in this species.

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