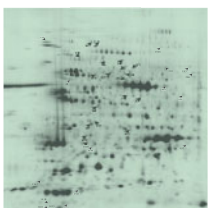


## New light on nodulation

With my long-standing interest in the cell cycle, my eye was inevitably drawn to the paper by **Gentili et al. (Umeå, Sweden and Bernal, Argentina, pp. 309–315)** on cell division and nodulation in *Alnus incana* following inoculation by the actinomycete *Frankia*. The *Alnus–Frankia* relationship is a rare example of a non-rhizobial N-fixing symbiosis; it is the early stages of development of the symbiosis that are discussed in this paper. The authors developed a light microscope technique that enabled them to observe intact roots and thus to show that the earliest changes in cell division

patterns occurred in the cortex: at 2 d after inoculation, anticlinal divisions were seen in the outer cortical layer in the region of the root where root hairs had started to become deformed. Root hair deformation and cortical cell division continued; by 6 d, there were dividing cells in the first three cortical layers. The development of this cortical cell division area (CCDA), which has not been described before, preceded the initiation of nodule primordia in the pericycle. The exact function of the CCDA is not clear but it may represent a ‘reservoir’ of dividing cells from which additional or replacement nodules may be formed. The authors went on to investigate the effects of P and N, given at different combinations of concentrations. The key findings were that at a ‘medium’ concentration of P (0.1 mM), the size of the CCDA and the number of nodule primordia were increased without any effect on root growth. Increasing the N concentration from low (0.71 mM) to high (6.45 mM) inhibited the early cortical cell divisions and counteracted the P-mediated increase in the number of nodule primordia. Thus, as the authors point out, the effects of N and P, and especially the latter, are evident very early in the establishment of the *Alnus–Frankia* symbiosis, before the formation of nodule primordia.

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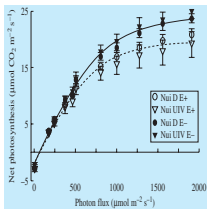


## Probing poplar's proteome

As the effects of climate change become clearer, plant breeders have turned their attention to plants that are able to survive or even thrive in temperatures that would be harmful to many species. One such heat-adapted species is *Populus euphratica*. It is described by **Ferreira et al. (Portugal–Scandinavia, pp. 361–377)** as a pioneer species growing along riversides in natural desert ecosystems and can survive at temperatures up to 50 °C provided it has a water supply. Experiments to determine membrane integrity (as indicated by rate of electrolyte leakage) indicate that the lethal

temperature lies between 50 and 55 °C. Such a plant is an ideal target for the breeder, but which genes should be the focus of attention? The authors have used a genome-wide proteomics approach to start to answer this question. This demands a large amount of work and essentially involves using 2D gel electrophoresis to fractionate proteins from control and heat-stressed leaves. The gels were scanned and the intensity of each spot determined by image analysis. The numbers generated by this type of experiment are large: the authors were able to identify a total of 1355 different proteins, of which 45 % showed changes in abundance of more than 50 % following exposure to heat stress. Individual proteins were then identified by cutting spots from the gels and obtaining a partial sequence for each spot by MALDI-TOF. This was successful for 82 % of the protein spots and thus provided an extensive picture of the major changes in protein expression associated with heat stress. The data set is too extensive for detailed comment here; readers are referred to the paper itself for the thorough presentation of these results. The next task, of course, is to determine which of these changes is most important for the heat adaptation of *P. euphratica*. Then the plant breeders can really get to work!

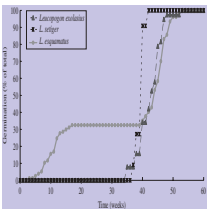
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### Numbers don't count when coming through the rye

Fungal endophytes occur frequently in grasses where the relationship between fungus and host is described as symbiotic. As discussed by Spiering *et al.* (Palmerston North, New Zealand and Wagga Wagga, Australia, pp. 379–387), the fitness of perennial ryegrass (*Lolium perenne*) is improved by fungal production of alkaloid anti-feedants, reducing the likelihood of herbivory. The endophyte is presumed to benefit from uptake of photosynthate and other nutrients from the host. However, there is much that remains unknown, especially about the dynamics of the interaction. The authors have worked on two genotypes of *L. perenne* that harbour different concentrations of

*Neotyphodium lolii*: genotype Niu D has approximately twice the concentration of endophyte as genotype Niu UIV. In actively growing plants, the endophyte had no effect on net photosynthesis at low light intensities but at high light intensities, when CO<sub>2</sub> is limiting, net photosynthesis was reduced by approx. 17%. The reason for this reduction in net photosynthesis (which did not occur in older, non-growing plants) is not clear. There was no change in transpiration (except in the dark), no increase in dark respiration and no effect on photon yield. However, it was clear that, in actively growing plants, the presence of the endophyte slowed leaf expansion and tillering rate but without affecting final plant biomass. For older plants that had ceased growing, the endophyte stimulated the growth of replanted tillers. Thus, as the authors rightly say, 'infection by *N. lolii*... both increases and decreases growth rates of its host'. Finally, none of the effects of the endophyte showed any significant differences based on endophyte concentration. Effects on the host plant are mediated more subtly than just by 'weight of numbers' and almost certainly involve an interplay of signals between host and endophyte, as has already been observed in relation to the growth synchrony of the two organisms.



### Get ready to go—then follow the fire

Fire is an ecological factor in several parts of the world; in regions in which fires are especially prevalent there are plant species that exhibit adaptations for living in such situations and even for making use of the effects of fire in their life cycles. Thus there are species in which seed dormancy is broken by the heat of the fire and/or by the effects of smoke. However, there are other adaptive strategies in relation to germination after fire, as described by Ooi *et al.* (Wollongong and Hurstville, Australia, pp. 421–430). They work with ericaceous shrubs in the genus *Leucopogon*. The

three species investigated, *L. exolasius*, *L. setiger* and *L. esquamatus*, all exhibit increased germination after a fire. However, it is clear from the authors' work that fire does not break seed dormancy. Seeds removed from freshly dispersed fruit of all three species are unable to germinate even under favourable conditions; treatment with smoke and/or heat does not break this dormancy. The authors subjected dormant seeds to several different treatments; here we concentrate on those incubated in conditions that mimicked seasonal changes in temperature, including a normal range of day–night fluctuation appropriate for each season. Although the timings over the incubation period differed between the three species, it was clear overall that the seasonal temperature changes led to breakage of dormancy. In nature, this pattern of dormancy breakage leads to seedling emergence in the autumn. What then is the role of fire? Once dormancy was broken, smoke treatment slightly stimulates germination while heat is inhibitory. In general then, despite their occurrence in fire-prone areas, germination is not significantly affected by fire itself. It may well be that for these seed banking species, it is the creation of open ground (and hence the change in the light environment) by fire that is a major stimulus for germination once dormancy is broken.

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