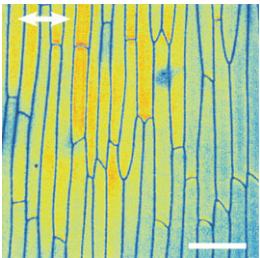


Making T provides breathing space

Discussion of aerenchyma formation usually focuses on two mechanisms. In the lysigenous mechanism, air-conducting spaces are formed by selective cell death, whereas in the schizogenous mechanism, cell layers split apart. However, a third mechanism, based on cell expansion, is also known. The rather cumbersome term *expansigenous aerenchyma* has been coined and although it was first discovered over 100 years ago, relatively little is

known about it. One species that exhibits this type of aerenchyma formation is the sponge gourd *Luffa cylindrica*. This is a flood-tolerant member of the Cucurbitaceae and subject of a study by [Shimamura *et al.* \(Ibakari and Fukuoka, Japan, pp. 1431–1439\)](#). The authors transferred young plants to 'continuously waterlogged conditions' with the water surface 10–20 mm above the soil. Within 4 days, new adventitious roots began to appear and as these roots developed they became very porous. There was also an increase in the porosity of the hypocotyl. Slits developed in the outer layers of the hypocotyl and of adventitious roots, possibly allowing direct access of O₂ to internal tissues. Detailed observations over a period of 16 days showed that aerenchyma was formed by outward radial expansion of cortical cells. In the hypocotyl this was a 'normal' expansion that, to a limited extent, pushed apart some of the cells in layers external to the cortex to form aerenchyma. However, in the adventitious roots the pattern of radial expansion was very different. Expansion was confined to a particular zone on the outermost cell surfaces, resulting in the outgrowth of a protuberance that pushes against the next cell layer. The cortical cells thus became T-shaped and air spaces were formed between the protuberances of adjacent cells to give an extensive aerenchyma. It will be very interesting to know how this specific and fascinating pattern of cortical cell growth is regulated but, as the authors clearly state, we currently know nothing about its physiological control.



Loose connections

Despite advances in our knowledge of plant cell-wall biochemistry, the mechanisms involved in loosening the wall for cell expansion are not completely understood. Proteins known as expansins are certainly involved in loosening. However, other enzymes, the xyloglucan endotransglucosylases (XETs), may also participate in this process, as discussed by [Van Sandt *et al.* \(Antwerpen, Belgium, pp. 1467–1473\)](#). XETs are capable of cutting and rejoining xyloglucans that tether adjacent cellulose microfibrils. Some members of the class also exhibit xyloglucan hydrolase (XEH) activity. Further, the XETs

show similar patterns of expression to those of the expansins in relation to active cell expansion, while their activity measured *in situ* is also correlated with growth. However, despite these indicative data, there has been to date no actual demonstration that XETs mediate cell-wall loosening for cell expansion. It is this problem that the authors have addressed using a simple *in vitro* system. A cDNA encoding the XET of *Selaginella kraussiana* was cloned and over-expressed to provide a purified enzyme. The test tissue was onion epidermis, one-cell-thick, highly anisotropic tissue, expansion of which was measured in two directions with a constant-load extensometer. Expansion in the direction parallel to the direction of the cellulose microfibrils was much less than transverse expansion. In both directions, expansion growth was greater at pH 4.5 than at pH 6.0; at pH 4.5, transverse expansion was strongly inhibited by prior heat denaturation; inhibition in the parallel direction was only slight. However, expansion in the transverse direction was largely restored (up to 66 %) by the addition of exogenous purified XET. Addition of a partly purified expansin preparation restored extension by 20 %. Enzyme addition did not stimulate expansion in parallel to the microfibrils in heat-denatured epidermis. These data thus show that XET can supply at least part of the enzyme activity needed for cell expansion and implicate XET directly in cell-wall loosening.



Pulling pollen through a pore

The stelar pollination system of angiosperms is very familiar. Less widely known is the system in gymnosperms in which the pollen enters the micropyle directly in order to reach the ovule. In many gymnosperms this process is aided by secretion from the micropyle of a liquid drop, the pollination drop, as discussed by [Mugnaini *et al.* \(Siena and Rome, Italy, pp. 1475–1481\)](#) in relation to *Juniperus communis*. In this species, the pollination drop, approx. 0.2 mm³ in volume, lasts about 12 days in the absence of pollination. If the drop is removed artificially, the plant can secrete another one for up to 4 consecutive days. Analysis of the drop shows that it is very sugary: 45.5 mg mL⁻¹ fructose, 8.30 mg mL⁻¹ glucose and a trace of mannitol. However, the most remarkable features of the pollination

drop are the responses to materials landing on it. It is already known that if compatible pollen lands on the drop it is withdrawn back into the ovule, facilitating the entry of the pollen. The authors have now extended our knowledge of this process by depositing a range of materials on the pollination drop. Viable *J. communis* pollen nearly always led to complete withdrawal of the drop; non-viable pollen or pollen from other species resulted mainly in partial withdrawal of the drop. This implies that the ovule is able to detect and respond to appropriate pollen, presumably via a biochemical signalling pathway. However, there is also a size component in the response: silica gel particles in the same size range as pollen elicited a full response in approx. 40 % of samples whereas larger particles mostly elicited no response at all. As the authors point out, it is thus possible that pollen-sized non-pollen particles may reduce the probability of successful pollination, a factor that could be significant in dusty habitats.



Learning more about lichens – nitrogen nutrition and reindeer raiders

In the gardening column of a UK national newspaper, a reader recently expressed concern about a grey-green fungus growing on her *Ribes* bushes. However, the reader was only half right. The growth was not a fungus but a lichen; its mis-identification representing the general lack of knowledge about these remarkable composite organisms. Despite their generally low profile and lack of public appeal, lichens are extremely important. For example, they are very sensitive to atmospheric pollution, making them good bio-indicators and, in some parts of the world, they are key components of the ecosystem. This aspect is discussed by [Kytöviita and Crittenden at Nottingham, UK \(pp. 1537–1545\)](#) in relation to lichens of the sub-arctic forests, where mat-forming lichens can make up over 90 % of the ground cover and may contain approx. 20 % of the ecosystem biomass. How then do lichens obtain and conserve N in these nutrient-poor ecosystems? To answer this question, the authors conducted N-feeding experiments and carried out N analysis in relation to growth in *Stereocaulon paschale* (N-fixing) and *Cladonia stellaris* (non-N-fixing). Feeding of nitrate to the basal regions resulted in translocation towards the growing upper regions, although the amount translocated was much greater in *Stereocaulon* than in *Cladonia*. By contrast, nitrate applied to the apical regions was not translocated to the lower parts. These observations correlate well with the predominance of apical growth in these lichens and with the decrease in N content along the apical to basal axis. The authors conclude that a ‘physiologically dependent translocation... follows a sink–source relationship’. In growth experiments where thalli were cut to different lengths, N content, especially at the apex, declined during the growth period, again reflecting the importance of translocation from the basal regions, which were of course missing in the cut thalli. Finally, although N-use efficiency and relative growth rate were greater in the non-N-fixing species, *C. stellaris*, its abundance in the field is limited because reindeer prefer it to *S. paschale*.

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