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

Elevated CO_2 concentrations — too much of a good thing?

The atmospheric partial pressure of CO_2 has been predicted to double by the end of the 21st century. It is widely assumed that increased CO_2 concentrations lead to increased rates of photosynthesis and plant growth. However, in reality, the situation is much more complex. This is well illustrated in the paper by **Pierce and colleagues from Sheffield, Bangor and Durham, UK (pp. 613–622).** They have been working with the grass *Poa annua* var. *vivipara.* This is actually a pseudoviviparous variety in which reproductive spikelets revert to the vegetative state, producing photosynthetic plantlets that are shed from the parent and become independently established. This mode of vegetative reproduction is usually regarded as a means of maintaining genotype in populations that are adapted to non-ideal conditions, such as low nutrient availability. The authors have investigated several facets of growth and physiology of this pseudoviviparous grass growing at low nutrient availability typical of its habitat and exposed to ambient and to twice ambient CO_2 partial pressures. Acclimation to elevated CO_2 reduces photosynthetic capacity and thus the plants do not utilize the increased carbon available. This has been observed in several other species, and for some of these it has been established that the increased CO_2 concentrations lead to a depression in the level of expression of genes encoding photosynthetic enzymes. Seed set tends to alleviate this depression because the seeds act as a major sink. However, in *Poa annua* var. *vivipara* seeds are not set, and further, the plantlets that are produced suffer the same decline in photosynthetic capacity as the parent plant. Parent plants also tend to senesce earlier, thus shortening the period of connection between the plantlets and the parent. Overall, reproductive efficiency is therefore decreased at the higher CO_2 partial pressure: an excess of CO_2 combined with low soil nutrient availability is clearly a disadvantageous combination for this pseudoviviparous grass.

Filmy fern physiology: a story of damp and shady places

For many years the filmy ferns have featured highly in my botanical affections. I recall, as a teenager, finding the two British species of *Hymenophyllum* and later, as a student, the thrill of peering into the entrance of a damp Irish cave to see the fronds of *Trichomanes speciosum*. And it is not just botanists who find this group interesting: the author John Buchan noted of one his manly heroes, stalking in the Scottish highlands, that he had by mid-morning seen both species of filmy fern (i.e. *H. tunbrigense* and *H. wilsonii*). However, as pointed out by **Michael Proctor (University of Exeter, pp. 715–725)**, the three filmy fern species of north-western Europe are outliers of a group that has many more species in damp habitats in the tropics and sub-tropics. Nevertheless, this paper focuses on the two north-western European *Hymenophyllum* species, *H. tunbrigense* and *H. wilsonii*, comparing several physiological features in relation to their slightly different habitat requirements. In terms of water relations, both species behave more like bryophytes than vascular plants and can survive dry periods, although they both favour damp habitats. In the wild, *H. wilsonii* may be found in habitats that are more prone both to total wetting and to periodic drying, and this is reflected in a greater tolerance of submersion and a higher ability to recover from exposure to reduced water potential than *H. tunbrigense*. Photosynthetically, both are shade plants. Photosynthesis saturates at low irradiances, and photo-bleaching damage occurs at relatively low levels of irradiance. However, there are further differences that reflect habitat preference. *H. tunbrigense* is generally found in deeper shade than *H. wilsonii* and photosynthetic saturation occurs at lower irradiances in the former than the latter. Overall, this is an interesting set of observations giving real insights into the ecology of these fascinating species.

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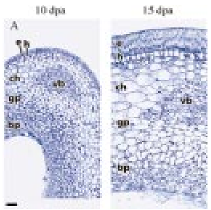
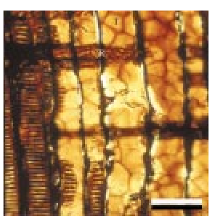


The seed coat — protector *and* provider

Many of us regard the main function of the seed coat as the protection of the embryo prior to germination. Of course that view is partially correct but we must not forget the role of the seed coat in seed development. There is considerable evidence from many dicots but especially from the 'grain' legumes, such as peas and beans, that the seed coat has a major function in transferring nutrients to the developing seed. This is the subject of the paper by **Van Dongen and colleagues from Utrecht and Wageningen (pp. 727–735)**, working on pea, *Pisum sativum*. A particularly noteworthy feature of their work is the combination of anatomical and cytological observations with studies of solute movement. For readers unfamiliar with the anatomy of the legume seed coat, its structure is surprisingly complex. The coat is vascularized by the branched chalazal vein and it is from the phloem of this vein that nutrients are unloaded into the parenchyma of the seed coat. The parenchyma actually consists of three layers, the chlorenchyma, the ground parenchyma and the 'branched' parenchyma with extensive intercellular spaces. Outside of the parenchyma are the hypodermis and the epidermis. As the embryo grows, the seed's liquid endosperm is absorbed and the developing cotyledons begin to contact the seed coat parenchyma. In the latter, the branched parenchyma has now collapsed, leaving liquid-filled spaces, and it is the ground parenchyma cells that are closest to the cotyledons. Experiments involving an inert fluorescent tracer molecule, HPTS, clearly revealed its movement from the chalazal phloem into the ground parenchyma and transfer out of those cells to the apoplast from which it was taken up by the cotyledons. Whether the ground parenchyma has specific 'efflux cells' is not yet clear; doubtless the authors are already working to answer this question.



Tyloses from times past

Some modes of fossilization have preserved the cellular structures of the plant in amazing detail. Indeed, the preservation may be so good as to allow direct comparisons with the cells of modern plants and to allow inferences to be drawn about the physiology of fossil species. In some fossils, preserved fungal hyphae are also visible, giving rise to speculations about the possibilities of commensalism or of disease. These features are beautifully illustrated in the paper by **Scheckler and Galtier (Blacksburg, Virginia and Montpellier, France, pp. 737–745)**. This paper is specifically focused on the presence of tyloses. In modern plants, these structures arise when living parenchyma cells grow into the conducting cells of the xylem. This nearly always occurs after the occurrence of an embolism, possibly caused by water stress, in the xylem cells. The function of tyloses is thought to be to block the embolic cells to maintain the efficiency of water conduction. Within the plant kingdom, tyloses occur most frequently among dicot angiosperms but they are known in most other groups of vascular plants. However, they have not been seen previously in the gymnosperm ancestors, the progymnosperms. Thus, the discovery by these authors of tyloses in the wood of *Protopitys buchiana* is especially significant. This is a progymnosperm tree from the early Carboniferous era; this is therefore not just the first observation of tyloses in a progymnosperm, but it is also temporally, the earliest known occurrence of these structures. Furthermore, the authors were able to show that in this very early wood, the location of tyloses in respect of xylem diameter, distribution of rays and proximity of parenchyma was very similar to that seen in modern dicots. They suggest therefore that back in the early Carboniferous, the physiological function of tyloses was similar to what it is now.

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