

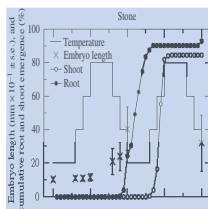


## Gini provides a tonic for root hair analysis

Root hairs are single-cell protuberances that elongate by tip growth, and which are formed from specialized precursor cells (trichoblasts) at particular locations in the growing root. Under some conditions, individual plants of the same species and genotype differ markedly in the density of root hairs, as shown in the very interesting study by a joint Chinese–American team based at Nanjing University and Pennsylvania State University (**He *et al.*, pp. 287–293**). They have applied a mathematical function, the Gini coefficient, to inequalities in root hair density in *Arabidopsis thaliana*. As

is very clearly explained by the authors, the Gini coefficient is based on the Lorenz curve that was originally used to describe inequalities in wealth distribution within human society, but it is equally applicable to studies of other types of inequality, including root hair density. Both density and inequality were greatly affected by the nutrient content of the growth medium, especially with respect to phosphorus (P). Under conditions of P sufficiency, root hair density was lowest and inter-plant inequality was highest. When the amount of available P was decreased, the root hair density increased. This is not, of course, a new observation, but what is new is the clear demonstration that the degree of inequality decreased as the provision of P declined. Indeed, at the lowest P concentrations used, the Gini coefficient was reduced almost to zero. Ethylene clearly has a role in these responses because inhibition of ethylene action at low P concentrations prevented the increase in density and the decrease in inequality, while addition of the ethylene precursor 1-methylcyclopropene at high P concentrations mimicked the effects of low P on density and inequality. Of course, what remain to be discovered are the internal control mechanisms by which these effects are manifest – a challenging line of further research for the authors.

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## Seed studies show complex story in shrub survival

Several years ago my interests in the plant cell division cycle took my group into research on seed dormancy. We soon learned that dormancy is a complex topic, as is well illustrated by the work of **Karlsson *et al.* (Linköping, Sweden and Murfreesboro, Tennessee, pp. 323–330)**. This group has studied dormancy and germination in a Mediterranean shrub, *Viburnum tinus*. The authors showed that removal of the pericarp (or at least the exocarp and mesocarp) is essential for germination, and thus the normal consumption of the fruit by birds plays a major role in seed dispersal. The seeds were

exposed to an artificial annual Mediterranean-type temperature cycle or to one of three constant diurnal cycles with no seasonal variation. Post-harvest embryo growth and emergence of radicle and shoot were monitored for 18 months, generating a complex data set. If the artificial annual cycle started with ‘winter’ (as in nature), post-harvest embryo growth started at about 30 weeks; root emergence was first seen at 38 weeks, with maximum germination (defined by root emergence) at 50 weeks. Shoot emergence was not detected until approx. week 53, with the plateau value being attained at about week 60. If, however, the annual regime had started with ‘summer’, all these timings came forward by up to 20 weeks. With seeds not exposed to annual fluctuations, the 5/15 °C and the 15/25 °C regimes inhibited root and shoot emergence (although there was embryo growth at 5/15 °C), whereas the seeds exposed to constant 10/20 °C were somewhat similar to those in the ‘summer-first’ annual cycle. From their data, the authors conclude that a weak physiological dormancy is broken, normally over a period of several weeks (with no particular temperature requirement), that roots emerge in the first spring after seed/fruit ripening and continue to grow, and that seedling establishment is completed in the second spring when the shoot emerges – a complex situation indeed.

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### Yes my darling daughter ... but don't take all the water

Crassulacean acid metabolism (CAM) is an aspect of plant biochemistry that has fascinated me for many years. Of course we now know that it is not a simple case of CAM versus C3 photosynthesis. There are constitutive CAM plants and inducible CAM plants, there are C3–CAM intermediates; there may be changes in C3 *versus* CAM activity or in CAM inducibility during development and there are variants of CAM biochemistry itself. CAM is still a subject for fruitful research, as illustrated by the work of **Pimienta-Barrios *et al.* (Jalisco, Mexico and UCLA, pp. 363–369)**. They compared the effects of drought on CO<sub>2</sub> uptake in cladodes of wild and cultivated *Opuntia ficus-indica*. Under cultivation, *O. ficus-indica* forms daughter cladodes very readily, whereas this is much less common in wild plants, and certainly never occurs in conditions of drought. These daughter cladodes exhibited C3 photosynthesis with daytime stomatal opening (again indicating a developmental factor in the ability to perform CAM) and thus had a higher demand for water than the CAM-performing mother cladodes. However, the daughter cladodes maintained their relative water content (RWC), even in periods of drought, and this was achieved at the expense of the mother cladodes whose RWC decreased, thus exacerbating the effects of drought on the mothers. In parallel with this decrease in RWC, the mother cladodes also exhibited a marked decrease, especially during drought, in CO<sub>2</sub> uptake within their normal CAM pathway. Further, these effects were cumulative, as the authors showed by carrying out their measurements on mother cladodes with between zero and eight daughters, although RWC of the mothers never fell below about 60 % (the authors suggest that at this value water is held more tightly by matric potentials). Overall, this paper provides another insight into the fascinating world of CAM plants (as well as showing the sacrifices that parents make for their offspring!).

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### Gender bending in a Mexican forest

Plant reproductive biology continues to provide fertile ground for good research. Take, for example, the phenomenon of distyly in hermaphrodite plants, the subject of the paper by **González *et al.* (Veracruz, Mexico, pp. 371–378)**. In distylous plants, there are two floral morphs that differ in respect of style length. The authors point out that in several species this ensures outbreeding because fertilization can only occur between the two different morphs. There are also species that, despite being morphologically hermaphrodite, allocate resources to female function in one morph and male function in the other, although complete ‘functional dioeciousness’ is rare. The work described in this paper was focused on a distylous hummingbird-pollinated shrub, *Palicourea padifolia*. It grows in Central American cloud forests and, at least in the population under investigation, the two morphs are equally represented. Allocations to male and female function were studied in the same population over a 5-year period. In general, the long-styled (LS) plants produced more flowers per inflorescence, perhaps indicating a tendency to male function (more flowers being equated with greater pollinator attraction and the possibility of greater donation of pollen). This is consistent with the observation that hummingbirds transfer pollen from LS to short-styled (SS) plants. However, pollen flow in the other direction does occur (both morphs set fruit) and this may be mediated by insects. In terms of female function, the data are variable. In two of the study years, SS plants clearly invested more in female function than did LS plants. In two years there was no difference and, in one of the study years, the LS plants were ‘more female’ than the SS plants. Functional gender expression, as the authors term it, in wild populations of *P. padifolia* thus varies from year to year, throwing doubt on previous single-year studies. It will be interesting to know what causes this variation.

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