field of the optical parametric oscillator would produce more than ten times squeezing in the absence of losses in the current experiment. Kimble estimates that with improvements in detector efficiencies and cavity parameters the squeezing that can be observed will approach this milestone.

At this level many of the proposed applications of squeezed light look promising. Progress in this area has so far exceeded expectations and we can reasonably expect further exciting developments in the next year. □

Dan Walls is Professor of Physics at the University of Waikato, Private Bag, Hamilton, New Zealand.

Plant biochemistry

Discovery of the most abundant inhibitor in the world?

Christine Foyer

THE regulation of the activity of the primary enzyme of photosynthetic carbon assimilation, ribulose-1,5-bisphosphate carboxylase, has remained one of the most confusing and elusive areas of plant biochemistry but the recent discovery and identification of an endogenous nocturnal inhibitor, namely 2-carboxy-D-arabinitol-1-phosphate (Gutteridge, S. *et al. Nature* **324,** 274; 1986 and Berry, J. A. *et al. Proc. natn. Acad. Sci. U.S.A.,* in the press), should help resolve discrepancies in our understanding of the modulation of what must be one of the most important enzymes in the biosphere. Together with related observations of a light-dependant activation protein that facilitates optimum enzyme function at ambient levels of carbon dioxide (Salvucci, M.E., Portis, A.R. and Ogren, W.L. *Photosynth. Res.* **7,** 193-201; 1985), this work forms the basis for a new understanding of the overall regulation of carbon assimilation.

Ribulose-1,5-bisphosphate carboxylase was first identified in 1956 but it was not until the mid 1970s that sufficient activity could be achieved *in vitro* to account for the rates of photosynthesis found *in vivo*. Activation of the enzyme requires carbamate formation on a lysine residue of the large subunit followed by reaction with Mg^{2+} ions to form a catalytically active enzyme–CO_2–Mg^{2+} complex but this knowledge provides only a glimpse of the functional capacity and regulation of the enzyme *in vivo*. Full activation of the enzyme *in vitro* requires high levels of carbon dioxide yet it occurs in leaves at ambient CO_2 concentrations. A further problem is that low concentrations of the enzyme activated with high CO_2 and high Mg^{2+} catalyse carboxylation showing distinctly biphasic kinetics with high rates of activity that decline after the first 15–30 seconds of the reaction to a lower steady rate.

A diurnal fluctuation in the specific activity of ribulose-1,5-bisphosphate carboxylase extracted from leaves has been observed in many plant species. Similarly, light activation and dark deactivation of the enzyme have been demonstrated in leaves, leaf protoplasts and isolated chloroplasts. The activation state of ribulose-1,5-bisphosphate carboxylase in leaves can be correlated with irradiance in a manner that cannot be attributed to changes in stromal *p*H and Mg^{2+}. A dark-induced inhibitor of the enzyme may be responsible for this modulation. When leaves are illuminated, photosynthetic carbon fixation shows an induction phase (or lag period) of several minutes before maximum rates are attained. Previous results have suggested that light activation of ribulose-1,5-bisphosphate carboxylase is not an important factor in determining the duration of the induction period but the presence of 2-carboxy-D-arabinitol-1-phosphate adds an extra factor, at least in species where the inhibitor is abundant.

The presence of a dark-induced inhibitor of ribulose-1,5-bisphosphate carboxylase is at once intriguing and puzzling. The degree of activation of the enzyme found in darkness is highly variable and it is not clear why photosynthetic carbon assimilation requires that ribulose-1,5-biophosphate carboxylase is relatively inactive in darkness. Several light-modulated enzymes are present in the pathway whose activity is negligible in the dark. These are activated on illumination long before photosynthesis overcomes the induction period. Now we find that there is another site of inhibition, and nature obviously requires a complete shutdown of the reductive pentose phosphate pathway in darkness.

2-carboxy-D-arabinitol-1-phosphate has so far only been identified in a limited number of species. There may, however be interspecific variation in the metabolism of the inhibitor and also differences in the conditions required for its retention during extraction procedures. We now need to know the biochemical pathways of synthesis and metabolism of this inhibitor and their regulation. Dr A. J. Keys (Rothamsted Experimental Station) has suggested that hamamelose bisphosphate could be a precursor of the inhibitor especially as this sugar-bisphosphate is made and rapidly turned over in the chloroplast. Synthesis and degradation may well be related to irradiance and therefore participate in the regulation of photosynthesis.

Ribulose-1,5-bisphosphate carboxylase has justly been called the most abundant protein in the world. As equimolar amounts of 2-carboxy-D-arabinitol-1-phosphate are required for optimum inhibition, this metabolite must be present in abundance in darkened leaves to be effective. This feature certainly limits any value this compound may have as a potential herbicide. But an understanding of the biochemistry and functional role of this inhibitor may suggest new areas for genetic manipulation of photosynthesis. □

Christine Foyer is at the Research Institute for Photosynthesis, University of Sheffield, Sheffield S10 2TN, UK.

100 years ago

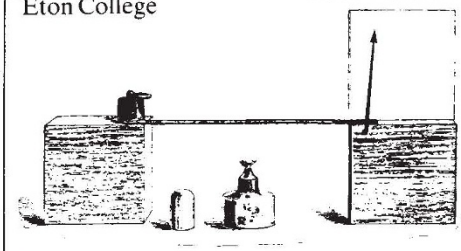
I VENTURE to call attention to a simple and effective way of demonstrating the linear expansion of solids when heated, first suggested, I believe, by M. Kapoustine (*Journal de Physique*, December 1883, p. 576). The principle is, to magnify the slight extension of a bar by causing the end of it to roll upon a needle, and thus turn the latter round and move a pointer attached to it through a sensible arc.

A small flat rod of the material to be examine is laid upon two wooden blocks, placed about 25 cm apart. A weight is put upon one end of the rod to keep it from moving; under the other end, at right angles to the length of the rod, is laid a fine sewing-needle, to the eye-end of which a light pointer of straw, about 16 or 20 cm long, is attached by sealing-wax. Behind the pointer (which is painted black) a screen of white cardboard is fixed on the wooden block by drawing pins.

Before the experiment is shown to an audience, it is well to make sure that the needle rolls fairly and freely between the bar and the block. Such precautions, however, are not in the slightest degree necessary for school-work; for there is always one thing which gives the typical boy greater pleasure than to see an experiment succeed, and that is — to see it fail.

H.G. MADAN

Eton College



From *Nature* **35,** 89; 25 November 1886.