CC/NUMBER 15
APRIL 15, 1985

This Week's Citation Classic™

Kelly G J, Latzko E & Gibbs M. Regulatory aspects of photosynthetic carbon metabolism. *Annu. Rev. Plant Physiol.* 27:181-205, 1976.
[Abteilung Chem. Pflanzenphysiol., Tech. Univ. München, Weihenstephan, Fed. Rep. Germany and Inst. for Photobiol. Cells and Organelles, Brandeis Univ., Waltham, MA]

The Calvin cycle and the C_4 pathway of photosynthesis are compared. The former is the only known autocatalytic sequence able to support plant growth. Also reviewed are regulatory properties of enzymes, including light-mediated activation; photorespiration; and starch and sucrose metabolism. [The *SCI*® indicates that this paper has been cited in over 135 publications, making it one of the nine most-cited papers published in this journal after 1975.]

Grahame J. Kelly
CSIRO Marine Laboratories
Hobart, Tasmania 7000
Australia

October 5, 1984

Prague in April 1974 was all-inspiring. The Old World character of the city and obvious charm of its inhabitants were not marred by the excessive hustle and bustle that irritates many cities. It was easy to think and talk there. Martin Gibbs, Erwin Latzko, and I were visiting Zdeněk Šesták, executive editor of *Photosynthetica*, and a genuinely wonderful host. He is even familiar to my daughters Madeleine and Vivienne (who were not born then) through his gift of *Knížka Ferdy Mravence* (a delightfully illustrated children's book by O. Sekora).

Well, naturally enough, we four (three seniors and I, the junior) discussed, among other topics, photosynthesis. In particular, we focused on photosynthetic carbon metabolism, which had experienced a formidable wave of advances during the preceding eight years. Hatch and Slack[1] had introduced C_4 plants. Work in the laboratories of Krotkov, Tolbert, and Zelitch,[2-4] and the discovery of ribulose bisphosphate oxygenase by Bowes, Ogren, and Hageman,[5] had established photorespiration as a major process, quite distinct from mitochondrial respiration. The principal lines of communication between the chloroplast and cytoplasm had been revealed by Heldt and Rapley's[6] discovery of chloroplast envelope translocators.

It was clear that carbon metabolism in the photosynthetic cell could no longer be viewed as comparable to the classic "metabolic map" of heterotrophic cells with a revolving Calvin cycle superimposed during the hours of sunshine. Other major processes, including the photorespiratory glycolate pathway and the carboxylation of phosphoenolpyruvate, were now recognized as part and parcel of the action in and around the chloroplast. The prominence of the latter (phosphoenolpyruvate carboxylation) in C_4 plants had created the illusion in some quarters that the C_4 pathway of photosynthesis could operate more or less independently of the Calvin cycle. This was unfortunate, since the discovery of C_4 plants was nothing less than a milestone in our understanding of the diversity and adaptability of photosynthetic carbon fixation. However, I must admit that, at that time, I was also experiencing considerable difficulty in getting the Calvin cycle-C_4 connections into perspective.

Other attractions occupied our attention in Prague, so it was not until later, back in Weihenstephan (and next to the oldest brewery in the world), that the fundamental difference between the C_4 pathway and the Calvin cycle was explained to me in an article by Walker.[7] His combination of phraseology and clarity in writing about photosynthesis set a model that I struggled to approach when Gibbs and Latzko, about a year later, invited me to prepare a first draft of what is now a *Citation Classic*. I suspect our paper has been recognized, not because it is an easy reference to almost any aspect of photosynthetic carbon metabolism, but because we strove to make a readable account of how dozens of scientists worked in an invisible mesh to unravel some of the details of nature's ultimate factory. Their efforts have not ceased, so we are continuing to write such accounts.[8]

1. **Hatch M D & Slack C R.** Photosynthesis by sugar-cane leaves. A new carboxylation reaction and the pathway of sugar formation. *Biochemical J.* 101:103-11, 1966. [See also: **Hatch M D.** Citation Classic. *Current Contents/ Agriculture, Biology & Environmental Sciences* 11(39):22, 29 September 1980.]
2. **Forrester M L, Krotkov G & Nelson C D.** Effect of oxygen on photosynthesis, photorespiration and respiration in detached leaves: I. Soybean. *Plant Physiol.* 41:422-7, 1966. (Cited 250 times.)
3. **Tolbert N E.** Microbodies—peroxisomes and glyoxysomes. *Annu. Rev. Plant Physiol.* 22:45-74, 1971. (Cited 480 times.)
4. **Zelitch I.** *Photosynthesis, photorespiration, and plant productivity.* New York: Academic Press, 1971. 347 p.
5. **Bowes G, Ogren W L & Hageman R H.** Phosphoglycolate production catalyzed by ribulose diphosphate carboxylase. *Biochem. Biophys. Res. Commun.* 45:716-22, 1971. (Cited 225 times.)
6. **Heldt H W & Rapley L.** Specific transport of inorganic phosphate, 3-phosphoglycerate and dihydroxyacetone phosphate, and of dicarboxylates across the inner membrane of spinach chloroplasts. *FEBS Lett.* 10:143-8, 1970. (Cited 180 times.)
7. **Walker D A.** Some characteristics of a primary carboxylating mechanism. (Pridham J B, ed.) *Plant carbohydrate biochemistry.* London: Academic Press, 1974. p. 7-26.
8. **Kelly G J & Latzko E.** Photosynthesis. Carbon metabolism: the profound effects of illumination on the metabolism of photosynthetic cells. *Prog. Bot.* 44:102-31. 1982.

