This Week's Citation Classic

Laing W A, Ogren W L & Hageman R H. Regulation of soybean net photosynthetic CO_2 fixation by the interaction of CO_2, O_2, and ribulose 1,5-diphosphate carboxylase. *Plant Physiol.* 54:678-85, 1974.
[Dept. Agron., Univ. Illinois, and US Regional Soybean Lab., North Central Region, Agr. Res. Serv., US Dept. Agr., Urbana, IL]

The regulation of photosynthesis and photorespiration was described by a simple model using the kinetic properties of the photosynthetic enzyme ribulose bisphosphate carboxylase. The effects of temperature and oxygen concentration on photosynthetic and photorespiratory gas exchange were explained by the model and this showed that these processes could be explained by the properties of this one enzyme. [The *SCI*® indicates that this paper has been cited in over 165 publications since 1974.]

W.A. Laing
Plant Physiology Division
Department of Scientific and
Industrial Research
Palmerston North
New Zealand

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"This paper represented part of my PhD thesis at the University of Illinois. My thesis adviser, R.H. Hageman, encouraged me to work in Bill Ogren's laboratory and continue my research interest in photosynthesis and photorespiration. I had arrived at Illinois soon after the exciting discovery by George Bowes and Ogren that O_2 inhibited ribulose bisphosphate (RuBP) carboxylase, the initial CO_2 fixing enzyme in photosynthesis.[1] They also had established that oxygen could substitute for CO_2 in the enzyme reaction to convert RuBP to phosphoglycolate.[2] Phosphoglycolate is hydrolysed to glycolate by a specific phosphatase.[3] Glycolate had been shown to be the precursor to photorespiratory CO_2 release and, although the metabolic pathway of glycolate to CO_2 had been firmly established,[4] several theories as to the source of glycolate and cause of oxygen inhibition were being advocated. Bowes and Ogren's observations provided the basis for understanding the interrelation between photosynthesis and photorespiration in terms of the oxygenation and carboxylation of RuBP carboxylase. In this paper, we showed that the kinetic properties of RuBP carboxylase and oxygenase could explain the effect of temperature and oxygen on photosynthesis and photorespiration. The regulation and interrelationship between two complex pathways were explained by a simple model—a rare event in plant science! The model was also able to satisfactorily explain the stoichiometry of photorespiration and photosynthesis and meet many of the critical requirements[3] of a theory for photosynthesis and photorespiration.

"This paper has been cited frequently as it, and earlier ones by Bowes and Ogren,[1,2] stimulated research into RuBP carboxylase. In part, this was because it showed the physiological relevance of biochemical studies into RuBP carboxylase. The subsequent research has verified the simple model[3] and firmly established the central position of RuBP carboxylase in the regulation of photorespiration and photosynthesis. Although the peak of publication of research into RuBP carboxylase seems to be past, the lull, I believe, is temporary and future breakthroughs will lead to manipulation of photosynthesis and photorespiration."

1. **Bowes G & Ogren W L.** Oxygen inhibition and other properties of soybean ribulose 1,5-diphosphate carboxylase. *J. Biol. Chem.* 247:2171-6, 1972.
[The *SCI* indicates that this paper has been cited in over 125 publications since 1972.]
2. **Bowes G, Ogren W L & Hageman R H.** Phosphoglycolate production catalysed by ribulose diphosphate carboxylase. *Biochem. Biophys. Res. Commun.* 45:716-22, 1971.
[The *SCI* indicates that this paper has been cited in over 205 publications since 1971.]
3. **Lorimer G H & Andrews T J.** The C_2 chemo- and photorespiratory carbon oxidation cycle. (Hatch M D & Boardman N K, eds.) *The biochemistry of plants.* New York: Academic Press, 1981. Vol. 8. p. 329-74.
4. **Tolbert N E.** Photorespiration. (Davies D D, ed.) *The biochemistry of plants.* New York: Academic Press, 1980. Vol. 2. p. 487-523.