The process of photorespiration in C₃ plants, as discussed in this review, comprises the oxygenation of ribulose bisphosphate (RuBP) and the metabolic pathway taken by the phosphoglycolate pool of C₄ species. This process is generally inhibited by O₂ with respect to CO₂ and therefore oxygenation of RuBP and subsequent photorespiration could be explained by the kinetic properties of RuBP carboxylase with respect to these two gaseous substrates. Thus, a primary objective of our review was to marshal evidence supporting the theory that the balance between photosynthesis and photorespiration was based on the dual activities of this bifunctional enzyme in that high CO₂ or low O₂ favored carboxylation and therefore photosynthesis, while low CO₂ or high O₂ favored oxygenation and therefore glycylate synthesis and photorespiration. Although this view was by no means generally accepted at the time, it has since withstood critical experimental scrutiny at the biochemical and physiological levels. This is perhaps one of the reasons why our review article has been so frequently cited over the past six years.

"In 1974, we were invited by the editor of Botanical Review to write a sequel to Andrew Goldsworthy’s excellent article on photorespiration which had appeared in the journal in 1970. While the previous review presented thorough coverage of the physiology of photorespiration, major advances had occurred in the intervening years with respect to the biochemistry of this complex process. Although it was generally accepted that glycolic acid, the substrate for photorespiration, was photosynthesized in the chloroplast and subsequently oxidized to CO₂ via the peroxisomal-mitochondrial pathway elucidated in Ed Tolbert’s laboratory at Michigan State, the mechanism of glycylate formation was both uncertain and heatedly debated. A major breakthrough in this area was the demonstration by George Bowes, a postdoc at Illinois, that the in vitro activity of the photosynthetic CO₂ fixing enzyme, ribulose 1,5-bisphosphate (RuBP) carboxylase, was competitively inhibited by O₂ with respect to CO₂ and that the same protein also catalyzed the oxygenation of RuBP to phosphoglycerate and phosphoglycolate, a precursor of glycolic acid, in the presence of molecular O₂. Subsequently, Bill Laing, a doctoral student at Illinois, demonstrated that the effects of CO₂ and O₂ on leaf photosynthesis and photorespiration could be explained by the kinetic properties of RuBP carboxylase with respect to these two gaseous substrates. Thus, a primary objective of our review was to marshal evidence supporting the theory that the balance between photosynthesis and photorespiration was based on the dual activities of this bifunctional enzyme in that high CO₂ or low O₂ favored carboxylation and therefore photosynthesis, while low CO₂ or high O₂ favored oxygenation and therefore glycylate synthesis and photorespiration. Although this view was by no means generally accepted at the time, it has since withstood critical experimental scrutiny at the biochemical and physiological levels. This is perhaps one of the reasons why our review article has been so frequently cited over the past six years.

A related controversy in 1974 was the mechanism by which certain higher plants, the so-called C₄ species, reduced photorespiratory CO₂ efflux from their leaves. The commonly held view at the time was that C₄ plants indeed photorespired at significant rates, but the resultant CO₂ evolved specifically in the chlorophyllous bundle sheath layer was efficiently recycled by an 'enolpyruvate carboxylase in the tightly surrounding mesophyll cells before it escaped from the leaf. However, progress in research related to the enzymatic properties of RuBP carboxylase and the biochemistry of C₄ photosynthesis in our own and other laboratories suggested a more attractive mechanism — C₄ plants had reduced photorespiration through the evolution of a specialized leaf anatomy and intercellularly compartmented enzyme complement which served as a biochemical CO₂-concentrating mechanism at the site of RuBP carboxylase/oxygenase in the bundle sheath. An elevated CO₂/O₂ ratio would allow CO₂ to compete more effectively with O₂ for RuBP, thereby decreasing the amount of glycylate available for photorespiratory oxidation to CO₂."