CC/NUMBER 39
SEPTEMBER 29, 1980

This Week's Citation Classic

Hatch M D & Slack C R. Photosynthesis by sugarcane leaves. A new carboxylation reaction and the pathway of sugar formation. *Biochemical J.* **101**:103-11, 1966. [David North Plant Research Centre, Colonial Sugar Refining Co. Ltd., Indooroopilly, Queensland, Australia]

The paper provides basic information about the metabolic events operating in a novel pathway of photosynthesis and presents a predictive model which served as a guide to subsequent investigations of this process. [The *SCI*® indicates that this paper has been cited over 260 times since 1966.]

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August 18, 1980

"This paper provides an example of the odd turn of events that surround so many scientific discoveries, and of the importance of being in the right place at the right time. In terms of identifying the unconventional nature of the photosynthetic process in sugarcane, the paper is not novel. Our studies were prompted by a communication from H. P. Kortschak, C. E. Hartt, and G. O. Burr whose $^{14}CO_2$ labeling studies suggested a role for malate and aspartate as early intermediates in photosynthetic CO_2 assimilation.[1] Only later did we discover that similar results had been reported about five years earlier by Yuri Karpilov who studied the closely related species *Zea mays* (corn).[2]

"At the time the paper of Kortschak *et al.* was published, Slack and I were fortunate to be working in a laboratory where the biochemistry and physiology of sugarcane was the major interest. Our current research efforts were nearing completion, so we decided to collaborate in an attempt to repeat and elaborate upon the Hawaiian worker's observation. Neither of us had previously worked in the field of photosynthesis, which was probably an advantage since we had fewer preconceived notions.

"Our first time-course labeling experiments, deliberately conducted under steady state conditions and at physiological levels of light and $^{14}CO_2$, confirmed the previous observation that malate and aspartate were labeled much more rapidly and to a far greater extent than would be expected if the conventional 'Calvin cycle' was operative. Various additional studies served to eliminate the possibility that the results might have been an experimental artifact. Using special procedures, we showed that oxaloacetate was probably the first product of CO_2 fixation. We were delighted when more elaborate pulsechase and time-course studies clearly showed that these C_4 acids were not metabolic end products, but behaved as rapidly metabolised intermediates of a photosynthetic CO_2-fixation pathway. From this data we proposed a scheme for photosynthetic CO_2 fixation in sugarcane in which CO_2 is initially incorporated into the C-4 carboxyl of C_4 acids and then transferred via the C-1 of 3-phosphoglycerate to intermediates of the Calvin cycle. This scheme still adequately describes the basic features of the pathway as it is presently envisaged.[3]

"During the next few years we perused studies on the mechanism, enzymology, and distribution of this pathway with surprisingly little competition from other laboratories. Early in the series of papers and reviews published before Slack and I went our separate ways in 1970, we suggested that this process be termed the 'C_4 dicarboxylic acid pathway of photosynthesis.' Over the years this has been reduced to 'C_4 pathway,' or simply 'C_4 photosynthesis.' "

1. **Kortschak H P, Hartt C K & Burr G O.** Carbon dioxide fixation in sugarcane leaves. *Plant Physiol.* **40**:209-13, 1965.
2. **Karpilov Y.** Distribution of radioactivity of carbon-14 among the products of photosynthesis in maize. *Trans. Kagan Agr. Inst.* **41**:15-24, 1960.
3. **Hatch M D.** C_4 pathway photosynthesis: mechanism and physiological function. *Trends Biochem. Sci.* **2**:199-202, 1977.