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This Week's Citation Classic

Kortschak H P, Hartt C E & Burr G O. Carbon dioxide fixation in sugarcane leaves. *Plant Physiol.* **40**:209-13, 1965. [Experiment Station of the Hawaiian Sugar Planters' Assoc, Honolulu, HI]

In sugarcane, carbon assimilation proceeds by a path qualitatively different from many other plants in that the first stable compounds formed in photosynthesis are malic and aspartic acids. These acids are converted to sucrose via 3-phosphoglyceric acid and hexose phosphates. [The *SCI*® indicates that this paper has been cited over 150 times since 1965.]

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"In 1952, after Calvin and his co-workers[1] had established the course of carbon in photosynthesis in *Chlorella,* and claimed that this was true for all plants, we decided that I should confirm that this was also the case for sugarcane.

"This required that I teach myself the new technique of paper chromatography, which included the determination of Rf values for over 100 compounds which we thought should be considered. The first chromatograph chamber was a glass cylinder with a canary feeding dish suspended from the rubber stopper to hold the solvent and paper strip. Radioactivity on chromatograms was counted by holding sections under a Geiger counter, the counted area being limited by a sheet-metal mask with a one-inch or one-fifth-inch opening, an extremely time-consuming task.

"By 1954, it was evident that PGA was not the first stable compound formed in sugarcane leaves. Actually, PGA had not been identified, as our purchased samples of 'glyceric acid' were not what they were supposed to be, and a custom-synthesized sample of C14-PGA gave at least three major peaks. No chemist I asked seemed to know a good synthesis of glyceric acid, but A.A. Benson kindly supplied a sample of his purified reference material, and I finally realized that deamination of serine provided an unequivocal synthesis, so this difficulty was removed.

"This project could not, of course, claim my full attention as our major interest at that time was translocation. By 1959, however, the main data reported in the final publication were complete. However, not until L. G. Nickell became head of the physiology and biochemistry department did I receive permission to publish in a recognized journal. With his support the skepticism of reviewers and editor was overcome and the work was finally published.

"A stumbling block at this time was that I could not imagine a reasonable reaction for the conversion of 4-carbon acids to the 3-carbon PGA without loss of carbon. I felt that knowledge of enzymes was needed, but at that time there was no one capable of such work at the Hawaiian Sugar Planters' Association. At a conference attended by M.D. Hatch, I urged him to take over the project with C.R. Slack. They soon confirmed my conclusions,[2] and from then on research on the C4 pathway exploded.

"The importance of the cooperation of two types of photosynthetic cells, the lack of photorespiration, the many species, both monocots and dicots which have this pathway, the reduced discrimination between carbon isotopes compared to Calvin-type plants, and the variations on the basic pattern, caused a whole new field of research to open, and this accounts for the large number of citations of this publication. C4 photosynthesis has been reviewed by Hatch and Osmond.'

"At the August 1980 meeting of the American Society of Plant Physiologists I was given the Charles F. Kettering award for this work."

1. **Benson A A, Kawauchi S, Hayes P & Calvin M.** The path of carbon in photosynthesis. *J. Amer. Chem. Soc.* **74**:4477-82, 1952.
2. **Hatch M D & Slack C R.** Photosynthesis by sugar-cane leaves. A new carboxylation reaction and the pathway of sugar formation. *Biochemical J.* **101**:I03-11, I966. [Citation Classic. *Current Contents/Agriculture, Biology & Environmental Science* (39):22, 29 September 1980.]
3. **Hatch M D & Osmond C B.** Compartmentation and transport in C4 photosynthesis. *Encyclopaedia of Plant Physiology, New Series* **3**:144-84, 1976.