CC/NUMBER 28
JULY 9, 1979

This Week's Citation Classic

Downton W J S & Tregunna E B. Carbon dioxide compensation—its relation to photosynthetic carboxylation reactions, systematics of the Gramineae, and leaf anatomy. *Can. J. Bot.* **46**:207-15, 1968. [Botany Department, University of British Columbia, Vancouver, British Columbia]

Plants with low CO_2 compensation values are shown to possess the newly discovered C4 pathway of photosynthesis[1] and a unique type of leaf anatomy in which chloroplasts are concentrated around vascular bundles. These correlations permit rapid screening of taxa for photosynthetic pathway. [The *SCI*® indicates that this paper has been cited over 120 times since 1968.]

W.J.S. Downton
CSIRO
Division of Horticultural Research
Adelaide, Australia, 5001

March 23, 1979

"Until Hatch and Slack[1] reported an alternative photosynthetic pathway to the Calvin cycle in sugarcane, the only suspected difference in photosynthetic physiology among higher plants was that corn and sugarcane lacked photorespiration. This difference was based primarily on the ability of these plants to completely remove CO_2 from a sealed system. At the time that the C_4 pathway *of* photosynthesis was proposed, I was a graduate student with the late E.B. Tregunna at the University of British Columbia and we had just found that certain grasses and some dicotyledons of the Amaranthaceae and Chenopodicaceae also possessed low CO_2 compensation values (Γ). When Hatch *et al.*[2] later reported that corn had the new photosynthetic pathway, we were tantalised by the possibility that low and the C_4 pathway might be related.

"Working in a climate of considerable scepticism regarding the reality of the new pathway and even doubts about the existence of photorespiration, we checked the species listed in Hatch *et al.*[2] for Γ and found low Γ and the new pathway to be invariably associated. $^{14}CO_2$ fixation by the low Γ dicots indicated that they also assimilated according to the C_4 scheme.

"We were particularly intrigued by the existence of both high and low Γ species in the genus *Atriplex.* An important clue came when during a sequence of Γ measurements we noticed that leaves from the low Γ plant *A. rosea* contained prominent green veins whereas the high Γ *A. hastata* did not. Microscopic examination of sectioned *A. rosea* leaves subsequently revealed a type of leaf anatomy resembling that in the low Γ grasses! This anatomical correlation immediately provided a simple and rapid means for identifying 'C_4' species.

"Our recognition of these and other relationships with the new pathway soon came to the attention of many botanists. As the C_4 pathway gained acceptance, researchers in physiology, biochemistry, anatomy, cytology, taxonomy, and ecology were quick to investigate aspects *of* the C_4 'syndrome' related to their specialties. The resultant ground swell of research activity, which no doubt contributed significantly to the frequent citation of our article, has over the past decade provided considerable insight into the intricate structural and functional relationships which constitute the C_4 pathway and led to the identification of over 900 'C_4' species."

1. **Hatch M D & Slack C R.** Photosynthesis by sugarcane leaves. A new carboxylation reaction and the pathway of sugar formation. *Biochem. J.* **101**:103-11, 1966.
2. **Hatch M D, Slack C R & Johnson H S.** Further studies on a new pathway of photosynthetic carbon dioxide fixation in sugarcane and its occurrence in other plant species. *Biochem. J.* **102**:417-22, 1967.