This Week's Citation Classic


This paper demonstrated that plant leaves exhibited marked differences in stoichiometry of cytosolic and chloroplastic forms of glutamine synthetase. The absence of cytosolic glutamine synthetase from the leaves of several species active in photorespiration suggested the reassimilation of photorespiratory ammonium occurred via chloroplastic glutamine synthetase and not the cytosolic isoform. [The SCI® indicates that this paper has been cited in more than 110 publications.]

Glutamine Synthetase Isoforms of Higher Plants
George R. Stewart
Department of Botany
University of Queensland
Brisbane, Queensland 4072
Australia

In 1974, the discovery of glutamate synthetase in plant tissues dramatically changed our ideas regarding the pathway of ammonium assimilation. This transformed glutamine synthetase from a rather mundane enzyme that synthesized the storage compound glutamine into a key enzyme of plant nitrogen metabolism. The Citation Classic article brought together two research groups that had discovered, more or less simultaneously, isoenzymes of glutamine synthetase in plant tissues. Shortly after, I moved to Birkbeck College, University of London, where the Agricultural and Food Research Council generously supported research into the occurrence and role of glutamine synthetase isoforms. Here, Sheila F. McNally joined me as a post-doctoral student.

At a meeting of the Society for Experimental Biology, a group from Orsay, France, and our group recognized the similarity of our talks, and we decided to publish a joint paper. This marked the beginning of the most productive period of many close friendships.

We were able to show that plant species differed with respect to the occurrence and relative amounts of glutamine synthetase. We found that four groups of plants could be recognized on the basis of differences in the stoichiometry of the isoforms in leaf tissue. One of the most important findings was that many plants with C3 photosynthesis lacked the cytosolic isoform of glutamine synthetase. In contrast, most of the C4 species that we examined had a high content of the cytosolic isoform. The importance of this lay in the proposal from the Rothamsted group that photorespiratory ammonium was reassimilated via cytosolic isoform. Our results ruled this out for many species, leaving a role in the photorespiratory nitrogen cycle for chloroplastic glutamine synthetase. Ironically the most decisive evidence confirming our hypothesis came from mutants of barley isolated by the Rothamsted group that lacked chloroplastic glutamine synthetase and could only grow under conditions that suppressed photorespiration.

The paper is frequently cited because it provides a comprehensive account of the occurrence of glutamine synthetase isoforms in plants having different physiological and ecological characteristics. However, the main reason for its success is the rise of plant molecular biology. In the 10 years since this study, our original biochemical findings have been developed at the molecular level by a number of groups, including B. Hirel, now at Versailles. For me, one of the most impressive pieces of work at the molecular level was the use of a reporter gene to show the tissue-specific synthesis of the nodule isoforms in transgenic Lotus.

My personal feeling about this paper is that it illustrates how rewarding collaborative science can be—the synthesis of two groups' findings proved more scientifically significant than if we had published independently. Certainly the subsequent collaborative work that we pursued proved no less rewarding—scientifically, gastronomically, and epistemically.


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