

Milborrow B V. The chemistry and physiology of abscisic acid.

Annu. Rev. Plant Physiol. 25:259-307, 1974.

[Shell Res. Ltd., Milstead Laboratory of Chemical Enzymology, Sittingbourne Laboratories, Kent, England]

The review brought together all aspects of the chemistry and physiology of abscisic acid. It listed physicochemical data, analogues that had been synthesized and their efficacies, the pathways of metabolism of abscisic acid, and the responses of a variety of bioassays. [The *SCI*® indicates that this paper has been cited in over 365 publications.]

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There is a slight embarrassment about finding that one's *Citation Classic* is a review because there is the feeling that it is really the work of others that has been selected. However, leafing through the pages of this paper brought back the memories of annotating some 600 papers, recalculating data, and checking cross-references so that the guilt was soon lessened by the remembrance that the review took considerably more effort than the average paper.

The timing was auspicious: abscisic acid was the fourth (fifth if one counts ethylene) plant hormone to be discovered, and our group had confirmed the proposed structure by synthesis.¹ We gave hundreds of 4-mg samples to laboratories around the world so that, during the decade beginning in 1963, the number of papers on abscisic acid doubled each year. By 1973, when the review was completed, it was just possible to encompass the whole field. We

obtained photocopies or reprints of all papers on abscisic acid, but the photocopying bill threatened to overwhelm the budget allocation for the whole laboratory; thereafter, we restricted ourselves to articles of particular interest. We felt that we understood the comments of students we overheard praising the (then) new photocopying machine installed in the chemistry library of Stanford University. After discussing how convenient it was, one remarked, "It used to take me half an hour to read a paper; now I can Xerox it in two minutes flat!"

In a more serious vein, the review has probably been cited frequently because it brought together, in a convenient form, many of the physicochemical properties of abscisic acid. It also attempted to stress its quantitative aspects wherever possible. This is the essence of science, but paradoxically, it is also a feature that is increasingly neglected in present-day research as the complexity and power of our machines increase. The quantitative approach is exemplified by the listing of 50-odd synthetic analogues, whose biological activity was compared by recalculating their published assay data in terms of a 50 percent effective dose and then expressing this in terms of the activity of (\pm)-abscisic acid. Exact comparisons were still difficult, however, because of the variety of bioassay systems used.

Abscisic acid shows a propensity to react unexpectedly: reactions that one would expect to occur smoothly do not work, and others take place in a quirkish fashion. The almost equal growth-inhibitory effects of the two mirror-image forms and the discovery that it was the first, and so far only, compound to disobey Mill's rule illustrate the point. An appropriate comment on the latter infarction appeared as a celebratory limerick.² Abscisic acid was reviewed again in 1980.³

[See reference 4 for a 1983 review citing Milborrow's *Classic*.]

1. Cornforth J W, Milborrow B V & Ryback G. Synthesis of (\pm)-abscisic acid. *Nature* 206:715, 1965. (Cited 160 times.)
2. Milborrow B V. Chemistry and biochemistry of abscisic acid. (Runekles V C, Sondheimer E & Walton D C, eds.) *Recent advances in phytochemistry. Vol. 7. The chemistry and biochemistry of plant hormones.* New York: Academic Press, 1974. p. 57-91.
3. Walton D C. Biochemistry and physiology of abscisic acid. *Annu. Rev. Plant Physiol.* 31:453-89, 1980. (Cited 190 times.)
4. Nizhko V F. Fiziologicheski aktivnye soedineniya i transport veshchestv v rasteniyakh (Physiologically active compounds and transport of substances in plants). *Fiziol. Biokhim. Kult. Rast.* 15:211-22, 1983.