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TONY SWAIN AND PHYTOCHEMICAL METHODS

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Abstract—A brief review is provided of Tony Swain's important contributions to the development of phytochemical methods in the period 1953–1970. © 1998 Elsevier Science Ltd. All rights reserved

Professor Tony Swain will long be remembered as the founding editor of two important international plant science journals, *Phytochemistry* and *Biochemical Systematics and Ecology* [1, 2]. He was an inspiring and brilliant research scientist and it is for these gifts that we remember him today, 10 years after his untimely death, at the age of 65, in a motor accident on 27 September 1987. His scientific career fell neatly into three parts: at the Low Temperature Station, Cambridge, 1949–65; at the Royal Botanic Gardens, Kew, 1970–76; and at Boston University, 1976–85.

My task here is to briefly consider Tony Swain's scientific contributions during his time at Cambridge. Our research careers ran in parallel along similar lines, although Tony, who obtained his Ph.D in 1948 and I mine in 1953, was my senior. Nevertheless, I went ahead of him as postdoctoral fellow with Ted Geissman at UCLA from 1953–1955, and Tony followed me out to California in 1956–57. Our paths crossed more frequently from 1958 onwards. I was working with geneticists at the John Innes Institute, then at Bayfordbury, Hertford and only an hour's car journey from Cambridge. More and more frequently, I travelled up to Cambridge to discuss research progress with Tony and his mentor, E. C. Bate-Smith, the Director of the Low Temperature Station. These two became the chief exponents of phenolic research internationally, publishing several important reviews together and at the same time founding the Plant Phenolics Group, later to become the Phytochemical Society of Europe. I was eventually invited to join them as a member of a triumvirate and I remember a visit to the Pharmaceutical Institute at Munich, at the invitation of L. Hörhammer and Hildebert Wagner, where we each gave a lecture to the students and were then fed on liver sausage and beer.

The period 1945–1960 was a really exciting time in plant science. The discovery of paper chromatography by Martin and Synge provided the means for the first time of surveying plants for their phenolic constituents, and also of separating and identifying them in a satisfactory manner. In the same period, spectrophotometers became readily available and, although cumbersome (changes in wavelength had to be made manually), provided the means of quantifying the phenolics that had been separated by paper chromatography.

Table 1. Early history of paper partition chromatography

1943	Gordon/Martin/Synge Amino acid separation
1948	Bate-Smith *Dahlia* anthocyanins
1949	Bate-Smith Flavones and other phenols
1950	Bate-Smith and Westall Structure/Rf/Rm value
1953	Nobel Prize to Martin/Synge

Tony worked closely with Bate-Smith during those first years at Cambridge and he developed the use of paper chromatography for separating anthocyanins, flavones and other phenols that had been started by Bate-Smith (Table 1). Tony Swain's first major contribution to plant science was the separation of the *Dahlia* flavonoids, carried out jointly with C.G. Nordström (Table 2). This was a pioneering investigation and set the model for most subsequent plant flavonoid studies over the next 20 years.

The first paper on the *Dahlia* flavonoids provided an accurate and elegant method for the identification of flavones and their glycosides, which worked satisfactorily on a micro-scale and was as rigorous chemi-

Table 2. Pioneering contributions of Tony Swain to paper chromatography

1953	Nordström/Swain Glycosides of *Dahlia*	*JCS*
1953	Swain PC of coumarins	*Biochem. J.*
1959	Chandler/Swain Separation of anthocyanins on polyamide	*Nature*
1964	Swain/Goldstein Quantitative analysis of phenolics including tannins	*Phytochemistry*

cally as any large scale separation [3]. *Dahlia* contains a complex mixture of closely related glycosides in the flowers so that a battery of solvent systems, in addition to the universally applied BAW, was necessary in order to achieve difficult separations. Methods for determining sugar : aglycone ratios were developed, as well as the means for locating the positions of sugar substituents by *O*-methylation, hydrolysis and detection of the appropriate flavone partial methyl ethers. Subsequent papers in the *Dahlia* series described the application of these methods to the chalcones and flavanones of other colour varieties [4, 5].

Having thus dealt with problems of flavonoid analysis, Tony turned his attention to the chromatography of related phenolics, but most notably to the study of plant tannins. Working with Judy Goldstein [6, 7] he developed methods of quantitative analysis and then successfully applied these methods to measure changes that occurred during fruit ripening. With Hillis [8], he demonstrated that leaves on the sunny side of a plum tree accumulated about 50% more tannin than leaves in the shade.

Having thus developed methods of measuring seasonal changes in phenolic levels in living plant tissues, Tony carried out a number of key experiments into phenolic biosynthesis. He compared light and dark grown strawberry leaves, measuring the differences in anthocyanin and flavolan levels [9] and determined the effect of various precursors on caffeic acid biosynthesis in sunflower leaves and potato tubers [10].

Two other features of his research career at Cambridge deserve mention. First, he was in such demand as a research leader that he eventually had more than one group at the Low Temperature Station working under his supervision. For example, in one applied piece of research, he successfully determined the cause of after-cooking blackening in potatoes [11]. Second, Tony was attracting many overseas workers to his laboratory. Those who came for some time included Eric Conn, Lee Creasey, Ted Hillis, John Friend and Alfred Meyer, but there were many others who called in more briefly during those golden summer months in Cambridge.

In this brief review of the Cambridge years, I have had no space to mention his other scientific interests in plant enzymology, biosynthesis and cell culture. I have yet to mention the fact that with P. Baruah he published a paper in the *Biochemical Journal* on estimation of β-glucosidase which became a citation classic [12]. I have also not included the founding of the journal *Phytochemistry* in 1961 and his busy first years as sole editor. It was not until 1972 that I became involved with the journal as an Associate Editor.

One memory of the Cambridge period stands out in my mind: Tony's organisation of the first international Symposium on chemical plant taxonomy sponsored by NATO and held in Paris. As a young scientist early in my career, it was a great privilege to take part and attend and I shall always be grateful to Tony for that opportunity.

There is no doubt in my mind that in Tony's case all the careful methodology worked through during the years in Cambridge bore fruit in later experiments in biochemical systematics and ecology carried out at Kew or Boston. Reliable plant analyses underlie all those exciting and pioneering experiments he and his co-workers carried out on the feeding choices of birds, lizards, tortoises and monkeys. Tony's contributions to plant evolution and chemical ecology are considered below in other contributions to the present symposium.

As I have written elsewhere, "scientific progress hinges on the continual discovery and extension of new laboratory methods and nowhere is this more evident that in the subject of plant biochemistry" [13]. It was Tony's skill as an experimental scientist to get things to work in that now classic period of phenolic research that characterised his research career. He was also an excellent research leader and knew exactly how to get the best out of his colleagues. In spite of an ever increasing work-load, he was always willing to devote time and energy to the research problems of others. It was typical of the man to interrupt his highly successful research years at Cambridge by agreeing to serve the British Government as a scientific secretary to Sir Solly Zuckerman in the Cabinet Office in Whitehall. It was also typical of Tony, after his government service, to spend two years, in a postdoctoral capacity at Harvard and then Yale, before resuming his research in England as Director of an ARC Unit in Plant Biochemistry at Kew Gardens. This period of his career is considered by Dr Gillian Cooper-Driver, in the following paper.

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