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Obituary

A.J.P. Martin (1910–2002)

The chromatographic community was greatly saddened by the death of A.J.P. Martin, the inventor of partition chromatography, paper chromatography and gas–liquid partition chromatography, on July 28.

Archer John Porter Martin was born on March 1, 1910, in London, the son of a general practitioner. After attending Bedford School, he enrolled in 1929 in Cambridge University. Martin was very practical and his talent already manifested itself in his school years: as the story tells, while in his teens, he became familiar with distillation, including the theoretical plate concept, and even built a distillation column from tin cans. (15 years later he made good use of this knowledge when developing the theory of chromatography.) Martin's original plan was to study chemical engineering; however, Cambridge did not offer such courses and so, he took the usual natural sciences curriculum. Halfway through he switched to biochemistry on the influence of J.B.S. Haldane. Due to the switching of courses he finished his undergraduate studies in 1932 with a fairly low degree and had some difficulty in being accepted for graduate

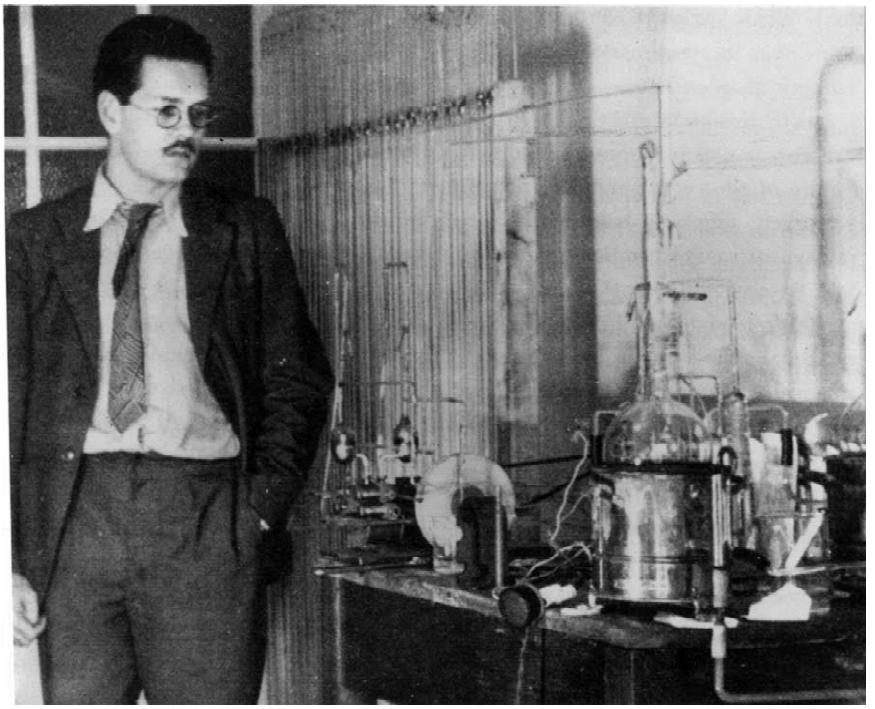

Fig. 1. A.J.P. Martin at the Dunn Nutritional Laboratory of Cambridge University, in the mid-1930s. In the background his countercurrent extraction apparatus can be seen [15].

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Fig. 2. A.J.P. Martin receives the 1952 Nobel Prize of Chemistry from King Gustaf VI Adolphus of Sweden. (Courtesy of the Nobel Foundation, Stockholm, Sweden.)

studies. However, evidently Haldane recognized his potential and helped him to overcome this burden. He started research with F.P. Bowden and C.P. Snow but was unhappy with his project and thus, one year later managed to be transferred to the Dunn Nutritional Laboratory at Cambridge. There he worked on Vitamin E and among others, constructed an elaborate countercurrent extraction apparatus. It consisted of 45 five-foot long tubes connected to one another and serving as the extraction funnels: 90 ball valves rattling loudly on their seats prevented the liquid from dropping back to the previous tube. Using this machine, he could separate various fractions and demonstrate the existence of three distinct varieties of Vitamin E.

Fig. 3. CIBA Foundation Symposium on Paper Electrophoresis, London, 1955. From left to right: Annemarie Lederer, A.J.P. Martin, Michael Lederer and R. Neher [16].

After receiving his doctorate Martin joined Sir Charles Martin (no relation) at Cambridge, who studied the antipellagra factor in pigs. They had a pigpen with 30 pigs and for three years it was Martin's responsibility to take care of their well being. Meanwhile R.L.M. Synge (four years younger than Martin) started to work in the Biochemical Laboratory at Cambridge, on his Ph.D., on a fellowship by the International Wool Secretariat, and among others, he tried to separate acetyl amino acids by liquid-liquid partition. Synge was advised to consult Martin whose complex countercurrent extraction apparatus was occupying much space in the entrance hall of the Nutritional Laboratory. This is when their productive cooperation started.

Soon Martin and Synge designed a new, complex, 40-stage countercurrent extraction machine which permitted partitioning between chloroform and water, the two solvents used by Synge for his studies. At that time they moved their operation, including the machine, to the laboratory of the Wool Industries Research Association, in Leeds, and continued their work there. (In a candid personal interview [1] Martin vividly described how they carried this apparatus from Cambridge to Leeds, on the running board of his car, driving at snail's pace.) Eventually they succeeded in the separation of the monoamino monocarboxylic acids present in wool [2]. However, it was a very tedious job: it took one week to achieve the separation, the machine needed continuous adjustments and working in a room filled with chloroform vapor was certainly not pleasant. They tried to simplify the technique: one of Martin's ideas was to pack a glass tube with a mixture of wool and cotton, with the fibers parallel to the axis of the tube, and to have chloroform flow above and water below the packing. Their hope was that the fibers will separate the two flows and the amino acids would distribute differentially between the two solvent flows. However, the system did not work. Martin realized that the problem was related to trying to create equilibria in two liquids moving continuously in the opposite direction. Then, one day, he suddenly came to a solution: move only one liquid and keep the other stationary. This was accomplished

Fig. 4. CIBA Foundation Symposium on Gas Chromatography in Biology and Medicine, London, 1969. A.J.P. Martin with (right) J. Janák. (Courtesy of J. Janák.)

by coating silica gel particles with water, packing this material into a tube and having chloroform continuously flow through the column. The sample was injected into the mobile phase stream that carried it through the column; during passage the individual sample components became separated due to the difference in their partition coefficients. This is how liquid–liquid partition chromatography for which 10 years later Martin and Synge received the Chemistry Nobel Prize, was born.

In the subsequent months Martin, together with Synge, had to solve many problems before the new technique could provide good, reproducible results. Their first report was presented on June 7, 1941, at a

Fig. 5. Sixth International Symposium on Advances in Chromatography, Miami, FL, 1970. A.J.P. Martin (center) with J.E. Lovelock (left) and A. Zlatkis (right) (Author's collection).

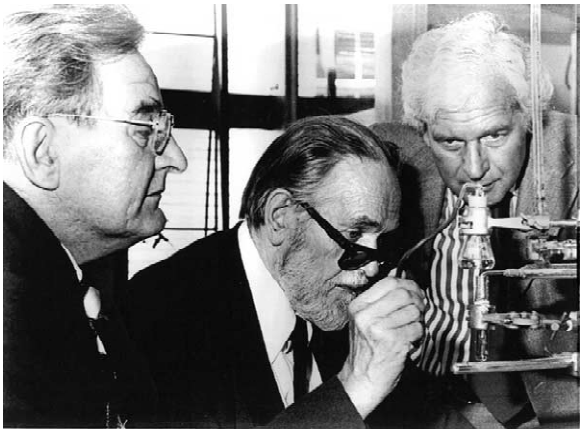

Fig. 6. A.J.P. Martin (center) with D.H. Desty (left) and V. Pretorius (right) at the University of Pretoria (South Africa), around 1975. (Courtesy of E.R. Adlard.)

Fig. 7. Twelfth International Symposium on Advances in Chromatography, Amsterdam, 1977. Left to right: M. Lederer, A.J.P. Martin, A. Zlatkis and G. Dijkstra [16].

Fig. 8. Fourteenth International Symposium on Chromatography, London, 1982. A.J.P. Martin with L.S. Ettre (right) [16].

meeting of the (British) Biochemical Society [3] where, according to Synge's recollections [4], they also demonstrated the technique of liquid–liquid chromatography. This was then followed by a detailed paper not only describing the new technique and its application to the separation of monocarboxylic amino acids, but also the theory of chromatography including the theoretical plate concept [5].

As the Hungarian proverb says, one gets a real appetite during eating, and this was also the situation in Martin's group to which meanwhile two young scientists – R. Consden and A.H. Gordon – joined. After the success in the separation of monocarboxylic acids, they tried to extend the technique to the separation of dicarboxylic amino acids; however, the silica gel used to support the stationary phase irreversible adsorbed them. Looking for a more suitable material they considered cellulose and found the easiest way to use filter paper strips impregnated with water as the stationary phase. This is how paper chromatography was developed [6]. Paper chromatography revolutionized biochemical analysis: investigations which formerly needed relatively large quantities of material and took months to be carried out using the laborious techniques of organic chemistry could now be accomplished in microgram amounts within a few days.

In 1946 Martin left the laboratory at Leeds. First he joined the research department of Boots in Nottingham; this, however, did not work out and so, in 1948, he moved to the National Institute for Medical Research, in London. There the problem of separating long-chain fatty acids by liquid chromatography arose, however, the system used in his original work in 1941, having a polar stationary phase and a less polar mobile phase was unsatisfactory. Martin's idea was to reverse the two phases, keeping the less polar phase stationary. A special problem to be solved was to find a hydrophobic support for this phase, and Martin solved this problem by treating kieselguhr with dichlorodimethylsilane vapor. (This was the beginning of the use of ''silanized supports'', reinvented ten years later by others for GC.) This new variant of liquid chromatography – named by Martin as ''reversed-phase chromatography'' – was described in 1950 in his paper co-authored with G.A. Howard [7]. This paper also introduced another innovation: changing the eluent strength during a chromatographic run. This was the start of gradient-elution chromatography.

In 1950, at the Institute, Martin was faced with the problem to obtain good separation of wide-range fatty acids and he suggested to go back to the idea first mentioned in his 1941 paper with Synge: carry out column chromatography, but using a gas instead of a liquid as the mobile phase. These investigations were carried out with A.T. James, a young collaborator who joined Martin at the Institute. The work was fairly straightforward and on October 20,

1950, they could already report on their preliminary results at a meeting of the Biochemical Society [8]. In the next two years news of the new technique slowly spread out not only in academia, but also to a few major industrial R&D laboratories. Their results were then finally published in 1952 [9] in a major paper and also in a major report presented by Martin at the First International Congress on Analytical Chemistry held September 4–9, 1952, in Oxford [10]. At this meeting senior representatives of major chemical laboratories in Europe and America learned the first time about the enormous potential of gas chromatography. From then on, the technique spread rapidly, revolutionizing analytical chemistry.

In his autobiography George A. Oláh (1994 Nobel Prize in Chemistry) mentions the frequently stated opinion that the Nobel Prize often represents the *de facto* end of the recipient's active research career [11]. In essence, this was true about Martin. After receiving the Prize, he remained for four more years at the National Institute of Medical Research, as head of the physical chemistry division, but from then on, he had no major achievements. After 1956 he has served as consultant to some companies and also had academic appointments at the University of Technology, in Eindhoven (1964–1974), the University of Sussex (1973–1974), the University of Houston, in Texas (1974–1980) and the Federal Technical University in Lausanne (1980–1985).

An idea which much occupied his thoughts from the late 1950s on, was the possibilities of carrying out chemical manipulations on a micro-scale. His lecture at the Hamburg Symposium, in June 1962, on this subject [12] was most thought-provoking and may be considered as the start of a subject that recently has been in the foreground of scientific research. In fact, this lecture is the best demonstration of Martin's activities in the later part of his life: intense mental work, contemplating a wide variety of subjects. I heard a story that while at the University of Houston, in the second part of the 1970s, Martin had to submit a report on his activities to the Foundation which endowed his chair, and his report consisted of a single sentence: ''I was thinking''. Indeed, Martin was full of ideas, not only in science but also related to sociology, some very unusual, many controversial, but always interesting. As expressed by S.R. Lipsky of Yale University, conversations with Martin were ''the most exhilarating, intensive, and exhausting exercises – an 'intellectual encounter of the first order; – that one can experience'' [13].

The last time I saw Martin was in the spring of 1985, in Urbino, at a special symposium honoring his 75th birthday. He also received an honorary doctorate from this old University, and many of his old friends were present to celebrate him. Unfortunately, one could already observe that his mind started to deteriorate: soon he was diagnosed suffering from Altzheimer's Disease and eventually, he had to be confined to a nursing home for the rest of his life.

I would like to end this obituary with the words of Professor Lipsky during the Symposium on Gas Chromatography in Biology and Medicine, organized on February 5–6, 1969, by the CIBA Foundation, honoring Martin [14]. I believe he spoke in the name of all of us:

> ''*I would like to pay tribute to the man whose genius was most responsible for it all, Professor A.J.P. Martin. He has twice made outstanding contributions to this field, in his discovery of partition chromatography and in his pioneering work on gas chromatography. He has thus altered for the better the lives of many of us. We, his scientific colleagues, thank him for allowing us to share with him this wonderful adventure.*''

Archer Martin was one of the greatest scientific minds of the 20th Century. His memory will live forever among the tens of thousands of chromatographers who utilize his achievements in their daily work.

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