Christina Cruickshank Miller

Christina Cruickshank Miller was born in 1899, and when about five years old was very ill with measles and rubella, which progressively and severely damaged her hearing. At primary school she was a good all-rounder, excelling in spelling and mental arithmetic. At her secondary school all pupils were taught chemistry and physics, so she never thought of science as a male prerogative. The initial science teaching by untrained teachers resulted in mediocre work by Chrissie, but later tuition by first-class graduates improved her performance dramatically; and she discovered how important an influence a well-qualified teacher can have.

For a female all-rounder good at mathematics, school-teaching seemed the only career open, but was barred by her deafness. A magazine article suggesting industrial analytical chemistry as a career for girls led to her choice of study. She was advised that the Heriot-Watt College gave better laboratory training than the University, but an industrial chemist told her father 'I wish to God I had a university degree'. In 1917 she found she could combine a three-year university course in chemistry with a four-year diploma course at the Heriot-Watt, subject to provisos about ancillary subjects, and examinations to be passed.

Because of the war the three-term courses at the University were compressed into two terms, creating a very heavy workload, exacerbated by the hearing problems, but in spite of this she produced first or good second class results throughout. She was always first in chemistry at the Heriot-Watt, but was warned that at the University there were always some brainy men at the top. She made no comment, but won the class medal. She graduated BSc with special distinction and gained a Vans Dunlop Scholarship, giving her the means to undertake research for a higher degree.

She was so impressed by Professor Sir James Walker that she greatly desired to work under his direction at the University, and saw him in 1920 while still taking the Heriot-Watt course. He told her to learn German and see him again in 1921. She mastered the language during her daily train journeys between Edinburgh and her home in Kirkcaldy. In 1921 she obtained the Diploma in Applied Chemistry and the Associateship of the Heriot-Watt College and had done some research on organic arsenicals and mercurials, in which analysis played an important part.

In 1921-24 she worked under Sir James on diffusion in solution, testing the validity of the Stokes-Einstein Law. She had great difficulty in achieving reliable results, because the chemistry building was still under construction and the facilities were crude or totally lacking. In the diffusion work prevention of convection currents was essential, for which a constant temperature room would be desirable but was not available until two years later. However, she learned a lot through having to use her own ingenuity, aided by Mr Walter Murray, the chief technician 'a genius brimful of ideas' who taught her glass-blowing (with soft soda-glass) so well that she was able to make nearly all the special apparatus needed. The research was successful and resulted in a PhD and sole authorship of a paper in the *Proceedings of the Royal Society,* London.

She had held a Carnegie Research Scholarship in 1922-24 and was now awarded a Fellowship for two years, enabling her to conduct independent research on a topic proposed by Sir James, namely to find whether the glow exhibited by phosphorus trioxide was responsible for the glow of phosphorus. The first two years yielded two publications, and the Carnegie Fellowship was renewed (unusually) for a third year, but on Sir James's advice she renounced the Fellowship, to accept an assistantship in the Chemistry Department, as a means to achieve her goal of a DSc before she was thirty. She bought a typewriter and taught herself to type, with a view to typing her thesis. The assistantship involved supervising third and fourth year students in the Advanced Inorganic Chemistry Laboratory under Dr Kay, a zealot for accuracy and precision.

The work on phosphorus trioxide continued, with final success in preparation of the pure oxide, which did not glow, and demonstration that the glow hitherto reported was due to traces of dissolved phosphorus. In 1929 she was proposed for promotion to a lectureship and Sir James advised her to submit her DSc thesis in good time. This thesis was said by the external examiner to be the best he had ever read. She graduated DSc (at 29) and was granted the lectureship with tenure. In 1930 she was awarded the Keith Prize by the Royal Society of Edinburgh for her work on phosphorus trioxide. The citation for the award quoted the doyen of inorganic chemistry in this country as saying "I regard Miss Miller's contribution to our knowledge of this subject as the most important advance made in the last twenty years". Her future was now assured, but earlier in that year a disastrous explosion in further work on the trioxide had cost her the sight of one eye, so that line of work was abandoned. She then turned to a new project in physical chemistry, but finding it too time-consuming to keep up with the rapidly expanding literature in both physical and analytical chemistry she decided to confine all further research to the latter, thus starting on what was the second high point in her academic career, with a long series of very good research students. Emphasis was placed on exploiting reduction in scale of operations in quantitative and qualitative analysis of inorganic samples. This led to an extensive range of research and publications.

After Dr Kay's death in 1933 Chrissie was appointed director of the teaching laboratory, and continuously updated the courses by introducing new instruments and techniques as they appeared, so that all chemistry students received a thorough grounding in analytical chemistry, with emphasis on accuracy and precision. All honours students received training in micro or semimicro quantitative analysis, the best of them being offered courses in organic and/or inorganic microanalysis, and were also used to test the new methods developed by Chrissie's research students. All student reports were carefully read and marked and the results entered in Chrissie's famous 'Black Book', a thick loose-leafbinder containing every result obtained from 1933 onwards, and used for statistical appraisal, and assignment of experiments to student demonstrators.

Besides the teaching and research load, Chrissie's expertise was much in demand for various purposes. During the war she prepared and equipped a laboratory for rapid detection of war gases, devised a scheme for twenty-four of these, prepared all the reagents, and tested the scheme extensively to ensure reliability. She also analysed numerous materials for the War Department, including samples of German origin. Her experience in microanalysis was often of use in examination of trace amounts of materials found in archaeology.

Her career was brought to an untimely end in 1961, when increasing hearing problems and family commitments (her mother and sister were semi-invalids) led her to seek early retirement.

As a teacher, Chrissie took endless care to give everyone the best training she could, spending countless hours at home marking practical reports and correcting errors in grammar, spelling and arithmetic. As a research supervisor she was enthusiastic and encouraging, appearing first thing in the morning to ask the plans for the day, and returning in late afternoon to hear the results. She had a quiet sense of humour, and was unfailingly polite, helpful and never seen to lose her temper (though she admitted to sometimes saying 'Grhhh'). Her memory was prodigious to the end of her life and could yield the name, degree and year of graduation for almost any student she had taught. After Chrissie's death, a 1958 graduate wrote 'She inspired logical thinking like no one else I've ever known; she would encourage endless debate and argument (reserving the option of switching off her hearing aid only in the most extreme of situations').

Chrissie was highly esteemed by many internationally renowned analysts and was noted for the clarity of her speech in public lectures. Her standing was recognised in 1949, when she was the only chemist among the first five women elected to Fellowship of the Royal Society of Edinburgh, and again in 1951 when she was awarded Honorary Fellowship of the Heriot-Watt College and was the only woman among the 25 Foundation Fellows. In 1945 she gave an invited lecture entitled Quantitative Inorganic Microanalysis for University Students, and in 1950 the Sir James Walker Memorial Lecture to the University Chemical Society.

There are many who feel that had she been less self-effacing she would have been one of Britain's first professors of Analytical Chemistry. To work with her was a privilege and a pleasure and to gain her approbation an accolade. She is well worthy of her inclusion in the Rayner-Canhams' book *Women Chemists of the Twentieth Century.*

Robert A. Chalmers

Christina Cruickshank Miller BSc, PhD, DSc, FH-WC: born 29 August 1899; elected FRSE 7 March 1949; died 16 July 2001.