



Crystallographer Kathleen Lonsdale was one of the first two women to be elected as a fellow of the UK Royal Society, in 1945.

THE WOMEN WHO CRACKED THE GLASS CEILING

After the First World War, female scientists gained footholds in academia as well as industrial and government research, despite facing prejudice and many other barriers. **By Sally Horrocks**

Scientific career opportunities saw a boost during the First World War as a result of the realignment of science to the military. For the first time, scientists worked on problems ranging from aviation and submarine detection to chemical warfare. After the war, this expansion continued, particularly in industry. Biochemist Kathleen Culhane Lathbury was one female scientist who benefited from that. During the 1920s and early 1930s, she worked for British Drug Houses, one of the leading pharmaceutical firms in the United Kingdom, which I focus on here. In her post, Lathbury oversaw insulin manufacturing.

But because the drug maker's dining room

was male-only, she was excluded from the social interactions that happen when dining with colleagues. In notes for a talk that she gave on women in the chemical industry, Lathbury said that the male graduate "is usually given quite a dignified position from the beginning. The girl who worked side by side with him at the university is hard up and constantly humiliated ... Even if her work is intellectually satisfying, she will be expected to attain results from the ground floor for which her male equivalent is given the help of a little altitude."

In my role as a science historian, since 2011, I have been senior academic adviser to An Oral History of British Science, a National Life Stories project in collaboration with the British Library.

The project has collected memories of the lives and careers of British scientists since the 1940s. (Edited extracts are available at www.bl.uk/voices-of-science, with full interviews accessible at sounds.bl.uk/oral-history/science.)

In 1922, Lathbury graduated from Royal Holloway College in London with a chemistry degree. She signed her job applications 'K. Culhane' to mask her gender, and worked for no pay at the Royal Institute of Chemistry, concluding that "for women in the chemical industry, magnificent health and a thick skin are more important than a knowledge of chemistry".

As her story demonstrates, the inter-war period was one of increased employment

Work / Careers

of women in science, but also of continued exclusion and segregation. After the First World War, what had been wartime research organizations grew, while those established before 1914, including corporate laboratories that had existed since the early 1890s, consolidated their positions, contributing to the growth of a new, technical middle class. But the career patterns of female scientists differed greatly from those of their male counterparts, and the disparity has persisted, even during the Second World War and the first few decades of the cold war.

In the United Kingdom – which I focus on here – women were also limited by an expectation that they would resign from work once they married. In some cases, including in the civil service, such resignation was a formal requirement with limited exceptions, so many of the women who enjoyed lengthy careers at government research organizations remained single. Women in the civil service could be exempted from this bar if their work was deemed to be of sufficient national importance, but, in practice, very few actually received exemptions.

One example of the paucity of exceptions was aeronautical engineering researcher Frances Bradfield, who studied mathematics and physics at Newnham College, Cambridge (a women's college established in 1871). She joined the UK government's Royal Aircraft Establishment (RAE) in Farnborough in 1918, along with fellow Newnham graduate Muriel Barker.

Bradfield remained at the RAE until her retirement in 1955, taking charge of small wind tunnels, mentoring many of her younger male colleagues and gaining the respect of her peers. Barker married colleague Hermann Glauert in 1922, and left her post.

Fellow Farnborough employee Beatrice Shilling, an expert on aero-engines, however, was one of the few who received an exemption when she married RAE mathematician George Naylor in 1938, leaving the RAE only when she retired in 1969. Shilling developed a device to counter engine cut-out in early Spitfire and Hurricane planes during the Battle of Britain in 1940.

Marriage and mobility

In 1945, X-ray crystallographer Kathleen Lonsdale (née Yardley) and biochemist Marjory Stephenson became the first two women to be elected fellows of the Royal Society, the United Kingdom's national academy of sciences. Stephenson, who was employed for much of her career by the Medical Research Council, had won her first university appointment in 1943.

Physics Nobel laureate William Henry Bragg had supported Lonsdale in her career at University College London and at the Royal Institution in London. Lonsdale worked from home after starting a family in 1929, and her husband assumed domestic responsibilities. A pacifist and penal reformer, Lonsdale served a month's sentence in London's Holloway Prison during



DAME STEPHANIE SHIRLEY

Stephanie Shirley built computers at the Post Office Research Station in the 1950s.

the Second World War because, as a Quaker, she refused to register for civil-defence duties.

Beryl Platt, by contrast, studied engineering at the University of Cambridge, UK, and joined the Hawker Aircraft Company in 1943. Platt had switched from mathematics to mechanical engineering (as one of 5 female students alongside 250 male undergraduates) when she arrived at Girton College in Cambridge two years earlier, because the UK government offered a state bursary to encourage engineering undergraduates as part of the war effort. After a brief post-war career in air safety for British European Airways, she ended her professional career in engineering when she married textiles manufacturer Stewart Platt in 1949.

Women who married fellow scientists, particularly those who worked in universities, were sometimes able to continue their involvement in research. Organic chemist Gertrude Robinson, who earned a master's degree in 1908, worked at the University of Manchester as a research assistant to Chaim Weizmann (who became Israel's first president in 1949), before marrying future Nobel laureate Robert Robinson in 1912. She collaborated with him on research in organic chemistry, publishing more than 30 papers. The couple spent a brief period at the University of Sydney in Australia,

one of the growing number of universities in the English-speaking world that recruited UK academic researchers and staff.

Such international mobility was a feature of professional scientific careers from the nineteenth century onwards, but men were more likely to take advantage of it than were women. More than 16% of UK-born chemists who joined the Royal Institute of Chemistry between 1887 and 1943 worked overseas at some point during their careers.

War work

As the world pivoted towards the Second World War in 1939, the United Kingdom started to see scientists as a national asset, and the Ministry of Labour and National Service established procedures for recruiting and training scientists and engineers. Men who were qualified to embark on courses in the physical sciences or in engineering were exempt from the armed services while they completed their degrees. These were compressed from three to two years, even in Scotland, where honours degrees typically last for four years. But the ministry actively discouraged universities from increasing the proportion of female students in science and engineering, despite the nation's demand for expertise.

Both women and men were directed into war work after completing their studies, however. Some were roped in even earlier. For example, microbiologist Nada Jennett (née Phillips) and fellow University of Bristol students spent one of their holidays working for pharmaceutical company Glaxo on penicillin production problems.

After the war, Jennett trained as a teacher and worked in laboratories at the university and in a hospital in Cardiff until her first child was born. She taught science part-time before returning to microbiology, then developed a second career lecturing in garden design.

For men, wartime work was often the foundation of long and successful careers, but for women it generally represented a short interlude before full-time domestic responsibilities, which might be followed by unpaid voluntary work or by part-time paid employment, but rarely a permanent post. Some employers who had been reluctant to hire women relented, among them Imperial Chemical Industries (ICI), then Britain's largest chemical manufacturer.

ICI advertisements specified a preference “for women chemists of British nationality”, perhaps helping to explain why refugee women who were scientists were not always able to find relevant work, even if they had impressive qualifications. In March 1941, for example, the journal *Chemistry and Industry* carried this advert: “LADY CHEMIST. German Refugee, aged 37. PhD (Berlin), seeks a position. Some research experience in Rubber Chemistry and accustomed to conduct searches in libraries and translate from German and French.”

Women who were married, had children and had left science to concentrate on domestic responsibilities but wanted to contribute to

the war effort also found suitable work hard to come by. Lathbury, for one, ended up working in statistical quality control at the Royal Ordnance Factory after a brief stint as a wages clerk.

In 1939, Joan Strothers and Sam Curran, then physics PhD students at the Cavendish Labo-

“For many women, continuing to work after marriage was often the only practical option.”

ratory in Cambridge, were trying to develop a proximity fuse, an explosives detonator that triggered only when near the target. They married a year later and moved to the Telecommunications Research Establishment, where Curran worked on centrimetric radar systems for installation in aircraft, while Strothers was part of the countermeasures group. Here, she developed the idea that led to Operation Window – the scattering of strips of metallic foil from aircraft to deceive enemy radar, a technique that was successfully used on D-Day.

Expanding opportunities

Towards the end of the Second World War, workforce planners expected a contraction in military research, enabling UK industry to recruit researchers to help recover the economy after the war. But this contraction proved short-lived. Defence research, including work on a British atomic-bomb project, rapidly expanded in the late 1940s and early 1950s, creating many new jobs in research organizations.

A small but growing number of graduate-level female scientists found employment in defence-research establishments and, thanks

to the 1946 abolition of the marriage bar in the civil service, could now continue their careers after marriage.

However, without maternity-leave legislation or a provision for childcare, many married women could not continue to work. And, although some enjoyed long careers, few reached senior positions.

An exception was the naval engineer Elizabeth Killick, whose career began in the early 1950s. Killick, who died in July 2019 aged 94, became deputy chief scientific officer and head of the Weapons Department at the Admiralty Underwater Weapons Establishment. In 1982, she also became the first woman to be elected to what is now the Royal Academy of Engineering.

Expanded UK government support for health, education, employment and social security after the Second World War also generated new opportunities for scientists, including posts in biological sciences, which tended to be popular with female researchers. Organizations such as the UK Public Health Laboratory Service and the advice services coordinated by what was then the Ministry of Agriculture, Fisheries and Food also employed women.

Measures agreed in 1955 meant that from 1960, women who worked for the state received the same wages as men. For women, this made careers in government research and universities more attractive than those in industry, in which differential pay rates and benefits remained the norm.

But even after the lifting of the marriage bar, women who did secure permanent academic posts often had to assume significant teaching and administrative burdens while their male colleagues were free to focus on research – work that brought greater prestige and faster promotion.

In 1947, for example, Florence R. Shaw was appointed to an assistant lectureship at University College, Leicester (now the University of Leicester), and was promoted to lecturer in 1948. But she published little after being elected a fellow of the Royal Institute of Chemistry in 1949 and, on her retirement in 1965, was praised for her teaching contribution as “a loyal and steadfast colleague in the Chemistry Department, to whom many of our graduates owe a great deal”.

Female researchers who pursued scientific careers during the post-war period faced emotional and practical challenges in the predominantly male environments. Many experienced self-doubt and had to come up with strategies to improve their status without seeming to be openly confrontational.

Stephanie Shirley, who arrived in the United Kingdom in 1939 as a refugee from Nazi Germany, worked at the Post Office Research Station in the 1950s, building computers from scratch. She recalls, “If you're the only one, if you fail, you fail for all women, and they say,



Engineer Beryl Platt (left) with an associate on the occasion of his wedding.



In the 1940s, Beatrice Shilling developed a device to stop aeroplane engines cutting out.

‘Well, we tried one of those and she was awful.’ Whereas if you succeed, it’s also remembered, but somehow the presumption is that, ‘We had her and she was good; at least we’ll try another one and see if it works again.’”

In the late 1960s, recognition of the barriers to women’s access to scientific careers began to grow. These obstacles came to be seen as problems that needed to be addressed, rather than as the inevitable consequences of women’s prioritizing of family obligations over career aspirations. From the 1970s, many of these formal barriers were removed. Female scientists in the United Kingdom and elsewhere benefited from legislative changes that promoted greater equality in employment and provided for maternity leave.

The three key pieces of UK legislation were the Equal Pay Act (1970); the Sex Discrimination Act (1975), which outlawed discrimination in employment on the grounds of gender or marital status; and the Employment Protection Act (1975), which established the principle of paid maternity leave, although it did not initially cover all women.

In the United States, Title IX of the Education Amendments Act (1972) outlawed discrimination on the basis of gender in education or activities receiving federal funding. But as Margaret Rossiter showed in the 2012 third volume of her book *Women Scientists in America*,

those researchers had to fight hard to ensure it was implemented.

At a global level, the United Nations decreed 1975 to be International Women’s Year, and the first UN Conference on Women was held that year in Mexico City. In 1979, the UN

“Greater diversity in the workforce came to be seen as an economic asset.”

Convention on the Elimination of All Forms of Discrimination Against Women was adopted.

The European Economic Community (from 1993, the European Community; from 2009, the European Union) was also a powerful force for promoting equality legislation in its member states, including the extension of maternity leave to all working women in the United Kingdom in 1993 and the extension of paternity leave in 2010. (Paid paternity leave was introduced in the United Kingdom in 2003.)

Legislative change and international conventions did not mean, however, that the expectations of employers or female scientists themselves changed suddenly, or that discrimination disappeared overnight.

Meteorologist Julia Slingo, whose first daughter was born in 1980, opted to leave

her job at the UK Met Office rather than take maternity leave. She returned to work in 1981 after being offered flexible working arrangements, an option she continued to take advantage of even after she accepted a new role in the United States in 1986. She later returned to full-time work and enjoyed a successful career before retiring in 2016 as chief scientist of the Met Office, a year after she was elected a fellow of the Royal Society.

Such flexible arrangements became more widely available from the 1990s. This was because greater diversity in the workforce came to be seen as an economic asset, making gender equality a matter of sound business practice rather than merely about the pursuit of social justice.

This business-case approach has also prompted efforts in Europe and the United States to address other aspects of diversity, including factors such as ethnicity, disability, sexual orientation and socio-economic status. Such an approach tends to focus on providing equality of opportunity to existing educational and employment structures rather than – as feminist critics have been advocating since at least the 1990s – on challenging the imbalances of power that form the basis of under-representation.

British female scientists who started their careers in the years after the First World War were a small minority in a relatively new profession that was concentrated in Europe and North America and was only just beginning to emerge elsewhere.

Their counterparts in the twenty-first century are members of a global community of nearly 8 million researchers. More than 40% of those are in Asia, although the proportion of female researchers worldwide is less than 30%. Whereas many of the formal barriers to women’s participation in UK science that existed in 1919 disappeared in the twentieth century, many fields continue to be numerically and structurally male. In these areas, career progress for women – as was the case a century ago – involves a challenging process of trying to work in male-oriented environments while seeking to maintain their own gender identities.

Female scientists might no longer be forced to choose between career or marriage and family. But they continue to face many challenges, with workplace cultures and reward structures still designed mainly to accommodate male-oriented norms and career paths.

Sally Horrocks is associate professor of contemporary British history at the University of Leicester, UK. She thanks members of the An Oral History of British Science team past and present, as well as Liz Bruton (Science Museum, London) and Graeme Gooday (University of Leeds, UK) for advice and encouragement.
e-mail: smh4@leicester.ac.uk