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Women testing explosives at a factory in Gretna, UK, turned yellow from the toxic TNT and were paid one-third less than their male colleagues.

A temporary liberation

The First World War ushered women into laboratories and factories. In Britain, it may have won them the vote, argues **Patricia Fara**, but not the battle for equality.

In the early twentieth century, female scientists felt beleaguered. It is “as though my work wore petticoats”, cries Ursula, the fictionalized version of distinguished physicist Hertha Ayrton in the 1924 novel *The Call*. The real-life Ayrton was denied entry to the Royal Society in 1902 because she was married; later she struggled to make the British government’s War Office consider her design for a wooden fan to protect soldiers against gas attacks. Pre-war, alongside fellow suffragettes, Ayrton had marched behind banners embroidered with scientific figureheads including Marie Curie and Florence Nightingale, but such protests

often aroused contempt rather than support.

“I do not agree with sex being brought into science at all,” declared Ayrton. “Either a woman is a good scientist, or she is not.” Ringing words — so have we yet achieved the ideal she was fighting for a century ago?

Overt discrimination is now illegal — equality of opportunity is firmly entrenched. But all over the world, traditional attitudes linger on. Glass ceilings and leaky pipelines still present tough challenges for ambitious women in science, especially at higher levels. Exposing prejudice is the first step to eliminating it. By examining the past, we can understand how we have arrived at the

present — and how to improve the future.

In Britain, where the suffragists and violent demonstrations had failed, the First World War persuaded the government that women belonged in the polling booth as well as the parlour. “Oh! This War! How it is tearing down walls and barriers, and battering in fast shut doors,” enthused a female journalist in 1915 in the *Women’s Liberal Review*. By 1918, women had helped Britain to victory by making drugs, explosives, insecticides, alloys, electrical instruments and other essential laboratory products, and by carrying out research, running hospitals and teaching students. ▶

▶ Yet after the war, it was almost universally assumed that female workers should give up their jobs and slip back into their previous roles as wives and mothers. Only much later did the authorities recognize the twin follies of converting highly educated men into cannon fodder and of failing to deploy female brains effectively.

FROM EMBROIDERY TO EXPLOSIVES

As men left in their thousands for the war front, women, encouraged by the suffragist movement, seized the chance to enter fields that were previously reserved for men, including science and industry. Those with little education were trained to carry out technical but relatively routine tasks — such as inspecting bombs, testing radio valves and synthesizing chemicals. Women with scientific training stepped in to fill empty positions in universities, museums, boys' schools and government departments, or volunteered to serve abroad.

For most women involved in scientific and industrial work, the war offered a temporary reprieve from domestic servitude or leisured boredom. Wartime statistics are unreliable, but the proportion of women in employment rose from less than one-quarter to more than one-third, many of them working in munitions. Old stereotypes prevailed, so women were mainly allocated boring, repetitive tasks. They were paid at lower rates than men and regarded as intellectually and emotionally inferior. Then, as now, critics focused on women's appearances, accusing them of behaving immorally by cutting their hair or wearing uniform. Even when working with dangerous equipment, female scientists were obliged to wear long restrictive skirts rather than practical trousers.

Many women were recruited into analytical chemistry because they were deemed to be well-suited to following routine recipes — but they were paid at around two-thirds of the men's rate for hazardous work. Housed in a 16-kilometre-long complex in Gretna near the Scottish–English border, women working on TNT (trinitrotoluene) and other explosives earned the nickname 'canary girls' because their skins turned yellow from the toxic environment.

In universities around the country, isolated handfuls of female researchers diverted their attention to secret military and medical projects. Highly qualified, these women had fought hard to pursue an academic career, often facing hostility from their own families and from the men who taught them. Banned from most scientific societies, they found it hard to get teaching posts. "Women high up in scientific positions, women with international reputations," protested the palaeobotanist Marie Stopes, "are shut out from the concourse of their intellectual fellows." One of the first female lecturers in science, Stopes studied coal power for the government during

the war, only later dedicating herself to sexual education and family planning.

Scientific women were keen to volunteer their expertise. "I can put all my time and energy at your service for the next 6 weeks," wrote Margaret Turner, a pharmacologist at the University College of Wales, to the government, "and am anxious to know whether the few helpers down here could not be allowed to contribute further to the needs of the country?" Little trace is left of women's

"The proportion of women in employment rose from less than one-quarter to more than one-third."

wartime activities, and details can be hard to glean. For example, in 1914, the chemist Frances Micklethwait joined a team in London making explosives and was awarded an MBE (Member of the British Empire), one of Britain's highest distinctions — but because the work was top secret, little further information has survived.

Unprecedented openings arose for a few women. Like other female curators, the palaeontologist Dorothea Bate was ineligible for an official position at the Natural History Museum in London, but a few months after the hostilities began she stepped in to replace men who had volunteered to fight abroad. As more men disappeared to the front, some never to return, Bate's role expanded, but she was still paid piecemeal, so her weekly earnings remained lower than those of less-skilled male assistants. Even after the war, pressure remained high because of the backlog of uncatalogued specimens, but it was not until 1928 that the museum permitted women to apply for jobs — the ones at salaries too low to attract men. Thirty-seven years later, Bate was still there and still on a temporary contract.

Protectionism could bring temporary

advantages. Up to 1914, the single-sex Balfour Biological Laboratory at the University of Cambridge offered a secluded environment in which women conducted high-level research in a supportive community. Crucial for the first generations of female scientists, the laboratory closed when the departure of male volunteers to the war increased the available places across the university.

Having successfully demonstrated their scientific prowess, women were no longer automatically excluded from laboratories and lecture theatres. Then and later, in emerging fields such as genetics and X-ray crystallography, a few men — including William Bateson and William Lawrence Bragg — welcomed women to their teams. Perhaps they recognized that those who had reached such an advanced level must be of an exceptionally high calibre and could be employed more cheaply than men to carry out the same work.

ENTRENCHED ATTITUDES

Like their male colleagues, the few female researchers spent the war years divorced from their own interests. In the artificial trenches dug in the gardens of Imperial College London, the pharmaceutical chemist Martha Whiteley experimented with her team of seven female assistants on explosives and poisonous gases. Almost 40 years later, in a 1953 lecture intended to inspire young women, she described examining the first sample of mustard gas, a blister agent, to arrive in Britain: "I naturally tested this property by applying a tiny smear to my arm and for nearly three months suffered great discomfort from the widespread open wound it caused in the bend of the elbow, and of which I still carry the scar." Unusually, Whiteley resumed her own research on organic analysis after the war.

Especially at the beginning of the war, the official policy was clear: women were



Physicist Hertha Ayrton (left) designed a fan to protect soldiers from poisonous gases; chemist Martha Whiteley (right) tested such gases in artificial trenches at Imperial College London.



AYRTON: SCIENCE PHOTO LIBRARY; WHITELEY: IMPERIAL COLLEGE ARCHIVES



© IMPERIAL WAR MUSEUM

Botanist Helen Gwynne-Vaughan, the first overseas commander of the Women's Army Auxiliary Corps and a commandant of the Women's Royal Air Force, painted by William Orpen (1918).

unsuitable for action overseas; their role was to keep the home fires burning. Patriotic scientists who relished the excitement and independence of travelling abroad had two main options — to volunteer for medical teams or to join the army.

Within a fortnight of war being declared, suffragist organizations had raised funds for a professionally staffed and fully equipped research hospital to be sent abroad. The offer was rejected by the War Office, which replied curtly that serving soldiers “did not want to be troubled with hysterical women”. By contrast, Britain's allies — including Belgium, Russia and France — eagerly accepted, and British female teams worked in Serbia and Thessaloniki, Greece, throughout the war, later joined by US units. In well-kitted laboratories they carried out research into tropical diseases such as malaria and dysentery. And like their foreign colleagues, including Austrian physicist Lise Meitner and Marie Curie, British female scientists volunteered as radiologists.

These volunteers endured atrocious conditions, building hospitals from scratch, often in freezing weather, and dealing with horrific injuries and illnesses. And they continued to experience substantial discrimination. The War Office decreed that the former research botanist Edith Stoney was unfit to become head radiologist in Thessaloniki because she was a woman. They would have changed their mind, commented the doctor Isabel Emslie Hutton, had they seen

her “carry heavy loads of equipment, repair electric wires sitting astride ridge tents in a howling gale, and work tirelessly on an almost starvation diet”.

Some scientists found themselves unexpectedly recruited for military service. Helen Gwynne-Vaughan was head of the botany department at Birkbeck College, London, when she was plucked from what she described as “perhaps the only sphere in which at that time young men and women worked freely together — the laboratories of a modern university”. As the first overseas commander of the newly formed Women's Army Auxiliary Corps (WAAC), Gwynne-Vaughan crossed the English Channel in 1917 “into a new and different world”. She immediately set about changing it, insisting that women be treated exactly the same as men, and persuading male officers that jokes such as “Would you rather have a slap in the eye or a WAAC on the knee?” would not be tolerated. After subsequently running the Women's Royal Air Force for a year, Gwynne-Vaughan returned to her former position laden with national honours, but keen to resume her research into the genetics of fungi — an important topic at a time when refrigerators were scarce and food transport was slow.

LABORATORY POLITICS

After the armistice, women over the age of 30 quickly gained the right to vote. Nonetheless, most were deemed extravagant

opportunists who were taking the rightful wages of fathers and husbands.

As soon as the men returned, university women were forced to relinquish their wartime positions, especially in lecturing, which was seen as a male preserve. A sympathetic chemistry professor protesting to the War Committee on behalf of his female colleagues wrote: “these women gave their services, services which have not received any public recognition”. At University College London, the female academics eventually secured a tea room (a former chemistry laboratory, with a gas burner in the fume cupboard) — one brave individual ventured into the men's common room and there was “such a sanacker-towzer of a row” that she backed out, defeated.

Although women did benefit from the post-war expansion of education and research, they still faced enormous obstacles in pursuing scientific careers. Female students, who had made up the majority during the war, were now outnumbered by men and were once again unwelcome in lecture rooms and laboratory classes. As the feminist journalist Cicely Hamilton lamented in 1935 that “we are retreating where once we advanced; in the eyes of certain modern statesmen women are not personalities — they are reproductive faculty personified.” At Cambridge, women could not formally graduate until 1948. Although some scientific societies accepted female members, separate common rooms survived until after the Second World War.

Scientific opportunities in industry opened up after the war, but married women with the vote often supported the conventional view that women belonged at home. As unemployment soared, they preferred available jobs to go to their menfolk, rather than to younger single women. Younger women were forced to take unskilled jobs at lower pay and found themselves trapped near the foot of the career ladder. As Kathleen Culhame, a disillusioned drugs researcher, explained: a male chemistry graduate could expect to progress well, but the “girl who worked side by side with him at the university is hard up and constantly humiliated ... She will be happier if she is not too enterprising because then her sense of frustration will be less.”

So, yes, the war enabled more women to enter science. But a century on we are still rooting out the discrimination that was built right into the heart of the system. ■

Patricia Fara is the senior tutor of Clare College at the University of Cambridge, UK. Her books include Science: A Four Thousand Year History and Scientists Anonymous: Great Stories of Women in Science.

e-mail: pf10006@cam.ac.uk