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‘All your dreadful scientific things’: women, science and education in the years around 1900

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Abstract

In the years around 1900 more women were benefitting from a university education and using it as pathway to acquiring research expertise and contributing to the development of scientific knowledge. Although numbers are small compared to men, it is clear that the idea of a female researcher was no longer an oddity. As illustrated by biographies and an analysis of 3 fictional texts featuring a female scientist, the increasing visibility of women did little to challenge the masculine colouring of science. A dissonance can be identified between femininity and science, even in settings sympathetic to a woman’s scientific activities. Particular unease is discernible when women are placed within the material culture of the laboratory and make use of the instruments of experimentation. The problem of a woman embodying scientific authority, especially at the time when science was professionalizing and institutionalizing, adds an additional layer of complexity to discussions about women, science and education in the late Victorian and Edwardian period.

Keywords:

Women; higher education; nineteenth century; 1900s; representation; laboratory

'All your dreadful scientific things': women, science and education in the years around 1900

When H.G. Wells' eponymous heroine, Ann Veronica, embarks on a course of comparative anatomy in a novel published in 1909, she finds that the study of science has a special and singular connotation. In particular, the advanced laboratory - with its material culture organised for the sole purpose of uncovering truth - provides a beacon of rationality and clarity which is in stark contrast to the confusion of life beyond the experimental space. The fictional student cohort, Ann Veronica informs us, happened to have an unusual proportion of girls and women that year. The class numbered 9 and 4 of these were women.[1] By the turn-of-the twentieth century, more women were accessing a formal university education in the sciences and so were entering the laboratory in greater numbers. Most of these students were present for teaching purposes; a smaller number of women were also accessing the experimental space to undertake research and scientific collaboration. Despite this, there remained ambivalence surrounding a scientific woman, including hesitancy with reference to her feminine identity and doubts as to her capacity to embody scientific authority. These tensions are most pronounced when connected to women's presence in the laboratory and appropriation of the instruments of research. For example, when Ann Veronica's suitor visits her laboratory at the fictional Central Imperial College he announces

> 'I want' he said, with a white hand outstretched, 'to take you out to tea.'
> 'I've been clearing up,' said Ann Veronica brightly.
> 'All your dreadful scientific things?' he said with a smile.
> 'All my dreadful scientific things,' said Ann Veronica.
>
> He stood back, smiling with an air of proprietorship, and looking about him at the business-like equipment of the room. The low ceiling made him seem abnormally tall. Ann Veronica wiped a scalpel, put a card over a watch-glass containing thin shreds of embryonic guinea-pig swimming in mauve stain, and dismantled her microscope.[2]

Ann Veronica is a relatively sympathetic portrayal of women's higher education in science and, for the most part, accepting of a woman's place in the laboratory (as a student at least).

[1] H.G. Wells, *Ann Veronica* (London: Everyman, 1999), 117
[2] Ibid., 196-7.

Despite this, there is still uncertainty: Ann Veronica's dreadful scientific things sit uneasily with her femininity, something she seems to recognise as she muses 'I'm not a good specimen of a woman. I've got a streak of male'.[3] Wells endorses this when, at the end of the novel, he has Ann Veronica give up her experiments in order to follow the more eugenically important role of motherhood, leaving science solely to her husband Capes.

This study will explore the landscape of science in the decades around 1900 and consider how the new breed of university-educated scientific women, particularly in their encounters with the material culture of the laboratory, were facilitated and understood. This will include women researching in the institutional laboratory and in the domestic space, and women's relations with scientific societies. The few, rare fictional portrayals of late Victorian and Edwardian scientific women can also provide an insight into contemporary understandings of science, experimentation and femininity. In addition to H.G. Wells' *Ann Veronica* (1909), texts referenced here include Wilkie Collins' *Heart and Science: A Story of the Present Time* (1883) and Edith Zangwill's *The Call* (1924). Fiction gives us a partial window into the minds of people of the past and clues as to how they constructed their world, their assumptions and their identities. This is especially valuable for the late nineteenth and early twentieth centuries which is the period when science was specialising and fragmenting while at the same time professionalising and moving, for the most part, from a domestic to an institutional setting. Science as a profession was therefore not yet wholly secure and was negotiating status in a process which encompassed gender as an important variable.

Women and science education: overview and context

Universities in England began opening their doors to women from around 1869; in that year Emily Davies co-founded what was to become Girton College, Cambridge, with the aim of creating a college like a man's. Here she hoped women would study all the traditional disciplines, including subjects such as Latin, mathematics and the sciences which were regarded as especially masculine.[4] Girton was followed by Newnham Hall, later Newnham College, Cambridge, in 1875. At Oxford, Somerville and Lady Margaret Hall opened in 1879

[3] Ibid., 177.
[4] Emily Davies, 'Special Systems of Education for Women (1868)' in *The Education Papers: Women's Quest for Equality in Britain 1850-1912,* ed. Dale Spender (London: Routledge, 1987), 99-110.

with 12 and 9 students respectively, however by that time over 300 women had already passed through the 2 women's colleges at Cambridge. Although Somerville and Lady Margaret Hall were joined by St Hugh's in 1886 and St Hilda's in 1893, the number of women students at the Oxford colleges remained small compared to those at Cambridge. For the scientifically-inclined moreover, Oxford was not the first choice for study. The most popular subject for women at Somerville College for was Modern History, followed by English and Modern Languages, with natural sciences and mathematics proving least popular – even though the College had been named for a female mathematician.[5] At Cambridge, women became increasingly visible in the natural sciences in the years around 1900, due in part to the opening of new woman-only laboratory facilities to prepare students for examination and also due to the effects of William Bateson's centre for research into Mendelian genetics which was largely staffed by women from Newnham.[6] Despite this, the number of women sitting the Natural Sciences tripos was low. As a snapshot, women were highest in representation in 1906 at 20 women to 170 men (Part 1) and in 1890 at 7 women to 21 men (in the advanced Part 2).[7]

The University of London is usually credited as the first institution to open its degrees to both sexes on an equal basis (except for medicine) in 1878. London's evolution was different to that of its Oxbridge counterparts; it was formed in 1836 as an examining body and, because of this, imposed no residential requirement on candidates presenting themselves for examination, something which proved particularly attractive to women. After 1898 the University became a federal Teaching University and began offering courses in its constituent colleges. In 1907 University College London (UCL), which in 1878 had also opened degree programmes in the Faculties of Sciences as well as Arts and Laws to women, ceased to have a separate existence and was incorporated into the University of London. Prior to this, in the years 1898-1900, women's colleges in London and Surrey had been incorporated including Bedford College, Westfield, Royal Holloway and King's College which had offered a 'Ladies' Department' since 1885; most of these offered programmes in the natural sciences

[5] Janet Howarth, '"In Oxford… but not of Oxford": The Women's Colleges', in *The History of the University of Oxford: Vol. VII, Nineteenth-Century Oxford, Part 2* ed. M. G. Brocks and M.C. Curthoys (Oxford: Clarendon Press, 2000), 237-307, 282-3

[6] Marsha L. Richmond, 'Women in the early history of genetics: William Bateson and the Newnham College mendelians, 1900-1910' *Isis*, 92 (2001), 55-90.

[7] Claire G. Jones, *Femininity, Mathematics and Science, 1880-1914* (Basingstoke: Palgrave Macmillan, 2009), 150-1.

and mathematics to women and, by 1900 there were 169 women awarded degrees across all subjects, representing over 30 per cent of the total.[8] University College London was particularly strong in the physical and natural sciences and women took advantage of this with a scattering of women graduating in subjects such as botany and zoology; Royal Holloway and Bedford Colleges were also noted for their strengths in science. Beyond Oxbridge and London, the new civic Universities in provincial cities which received their charters in the years around 1900 admitted women to science programmes, for the most part at least, on equal terms to men.

This is only a brief overview of the opportunities beginning to open up for middle-class, scientifically inclined women and it is important not to overestimate; however, a culture of women in science was emerging and the idea of a formally-educated woman of science was no longer something beyond imagination. Of course, late Victorian and Edwardian sexual science still warned of the threat posed to a woman's mental and reproductive health by exposing her to the same, intellectually demanding learning environment experienced by men. Science and mathematics in particular were singled out as cause of concern due to their characterization as abstract, hard disciplines too demanding for the female brain to cope with. There were two prongs to this attack: women did not have the intellectual capacity for original work, and, if they attempted it, their health may suffer. In *The Descent of Man* (1871) Darwin had devoted a section to 'Difference in the Mental Powers of the Two Sexes', concluding that due to the effects of natural and sexual selection, woman had stronger powers of intuition, rapid perception and imitation, but that these were characteristic of a lower state of civilization. 'The chief distinction in the intellectual powers of the two sexes' Darwin continues, 'is shewn by man's attaining to a higher eminence, in whatever he takes up, than can woman – whether requiring deep thought, reason or imagination, or merely the use of the senses and hands'. Therefore, he concludes, the average mental power in man must be above that of woman.[9] Informed by this evolutionary understanding, other men of science and medicine reiterated the problem. For example, Herbert Spencer wrote that the female brain did not have the intellectual sophistication for science and that women were incapable of framing a hypothesis and reasoning upon it.[10] In similar vein, William Withers Moore used his 1886 address to the British Medical Association to warn against a high level of education

[8] Negley Harte, *The University of London 1836-1986: An Illustrated History* (London: Athlone Press, 1986), 128.
[9] Charles Darwin, *The Descent of Man* (London: Penguin, 2004), 629.
[10] Leigh Ann Whaley, *Women's History as Scientists: A Guide to the Debates* (California: ABC Clio, 2003), 146.

for adolescents and young women due to the dangers it presented to female health and well-being.[11] In response to these health worries, in 1890 women's colleges at Oxford and Cambridge came together to carry out research into the health, marriage and child birth patterns of former students. Their findings undermined medical opinion in concluding that college-educated women were healthy and less likely to have childless marriages than their less-educated sisters and cousins.[12] However, as the first decade of the twentieth century progressed and more women accessed a 'masculine' education without ill effects – and as more women made their presence felt in science too - these worries began to abate.

Making a way in science

Discounting teaching in one of the new girls' schools emerging at the end of the nineteenth century, there was no such thing as a typical career for a female science graduate. Marie Stopes (1880 – 1958) is known today for her work in birth control, however she was a scientist first, having gained a BSc with double honours in botany and geology from UCL in 1902 and a PhD in Botany from Munich in 1904. Marie was subsequently appointed assistant lecturer in botany at Manchester University. In 1907, she was awarded a Royal Society grant for paleobotanical research in Japan and spent 2 years at the University of Tokyo, excavating rare fossil specimens and working in the university laboratory. Marie is credited with making key insights, in particular into coal-forest ecology, and being the first to view coal forests as a living eco system rather than just dead fossils, an understanding which did not re-emerge until 50 years later.[13] It has been estimated that in the half of the twentieth century, over a third of British paleobotonists working on carboniferous plants were women and that women, neither before or after, have played such a prominent role in that field.[14] At UCL, Karl Pearson employed a number of women in his Biometrics Laboratory, which applied statistical analysis to eugenics and evolutionary research, including Alice Lee. Alice had studied mathematics at Bedford College and went on to gain a DSc in craniometry (skull capacity)

[11] Lorna Duffin, 'The Conspicuous Consumptive: Woman as an Invalid' in *The Nineteenth-Century Woman: her Cultural and Physical World* ed. Sara Delamont and Lorna Duffin (London: Routledge, 2012), 26-56, 38.
[12] Mrs Henry Sidgwick, *Health statistics of women students of Cambridge and Oxford and of their sisters* (Cambridge: Cambridge University Press, 1890).
[13] H. E. Fraser and C. J. Cleal, 'The contribution of British women to Carboniferous paleobotany during the first half of the 20th century' in *The Role of Women in the history of Geology* ed, C. V. Burek and B. Higgs (London: Geological Society, 2007), 51-82.
[14] Ibid., 51.

from the University of London in 1901 under Pearson's guidance.[15] Soon after completing the Mathematics tripos at Girton College in 1889, astronomer Annie Russell Maunder (1868-1947) was appointed a 'computer' in the solar department of the Royal Greenwich Observatory, where she met her husband Edward Maunder. On marriage she was required to give up her job, but she did not give up her science. Annie developed expertise in practical astronomy and photographed key phenomena while on solar eclipse expeditions. She published jointly with her husband, including a well-received 1910 text *The Heavens and their Story* which was principally solely her own work. Annie edited the Journal of the British Astronomical Society for 15 years and was one of the first female fellows of the Royal Astronomical Society when it finally admitted women in 1916.[16]

Botanist Ethel Sargant (1863-1918) made significant contributions to her field; she was one of the first women elected a fellow of the Linnaean Society in 1904 (with Rina Scott, discussed below, and others) and the first woman to serve on its council; in 1913 she also became the first woman to serve as a section president of the British Association for the Advancement for Science. Ethel had studied at Girton and completed the Natural Sciences tripos in 1885, thereafter taking a research post at the Jodrell Laboratory at Kew. She left Kew after a year and from then onwards worked in her own home-based laboratory where she would be visited by Girton students seeking tuition.[17] Sargant published over 20 papers including one in collaboration with Henderina (Rina) Scott (1862 - 1929). Rina had developed her botanic interests at the Royal College of Science in South Kensington where, she attended advanced classes in botany held by D.H. Scott who she married shortly after in 1887. Scott was known for his support of female scientists, as an obituary makes clear: 'All women should honour the memory of Dr D.H. Scott, for he was the first lecturer on Botany at University College who allowed women to enter his class.'[18] After marriage, Rina carried out her own research as well as collaborating with Scott (a man of independent means) in their own home-based facilities. One of Rina's areas of research was done completely

[15] R. Love, 'Alice in Eugenics-Land: Feminism and eugenics in the scientific careers of Alice Lee and Ethel Elderton', *Annals of Science*, 36 (1979), 145-158.
[16] M. T. Brück, 'Maunder, Annie Scott Dill (1868–1947)' in *Oxford Dictionary of National Biography*, online ed., edited by Lawrence Goldman. (Oxford: OUP, 2004).
http://www.oxforddnb.com.liverpool.idm.oclc.org/view/article/46494 (accessed March 15, 2016).
[17] Mary R. S. Creese, 'Sargant, Ethel (1863–1918)' *Oxford Dictionary of National Biography*, online ed., edited by Lawrence Goldman. (Oxford: OUP, 2004).
http://www.oxforddnb.com.liverpool.idm.oclc.org/view/article/37935 (accessed 15 March 2016)
[18] F.W.O and A.C.S, 'Dukinfield Henry Scott 1854-1934', *Obituary Notices of the Royal Society*, 1 (1934), 205-27, 208.

independently. She made use of an early cinematograph, a film camera with a projector and developer invented in the 1890s, to record what she called 'animated photographs' of the growth and movement of plants. Rina showed, in slow motion time-lapse photography, the opening of buds, pollination by a bee, the unravelling of a shoot and other manifestations of plant activity.[19] Rina's slow motion film of plant growth and insect activity is a very early example of this technology being used for scientific research, yet she is not included in the histories which mostly refer to Pfeffer's 1898 recording of the growth of beans and Pizon's 1904 recording of a colony of bacteria.[20]

This is only a brief illustration of the activities of some of the women practising science in the years around 1900. These female scientists were not unique: between 1880 and 1914 some 60 women together published more than 170 papers in the Royal Society *Proceedings* and *Philosophical Transactions*.[21] Numbers are small compared to male authors, and many of these contributions were collaborations with men, often these women's University tutors, but nonetheless students in the biological, chemical and physical sciences at the new women's colleges were making their presence felt. Although these women were pushing at the door of learned scientific societies, the elite ones at least proved reluctant to include them. The Royal Society may publish women's papers and invite women to demonstrate their research at an annual conversazione, as did Rina Scott, Annie Maunder and a handful of other female scientists in the first years of the twentieth century; the Society may even award the odd woman a research grant and or a medal, as they did to physicist and electrical engineer Hertha Ayrton in 1906. However, to admit these scientifically-educated women into the fellowship was perceived as a threat, as illustrated with reference to Hertha Ayrton below. As new scientific specialisms emerged, and societies were founded to promote them, so elite scientific societies began to regard the retention of male exclusivity as a safeguard of their status – a status embodied, literally, in the bodies of their fellows or members. At times conflicted attitudes to women could lead to inconsistency and fudge. On 12 Feb 1905, the *New York Times* considered the issue and remarked that the British Royal Microscopical Society admits women to the extent of accepting full fees from them, although they are not allowed to attend meetings of the Society or to take part in its discussions. 'The money they

[19] Rina's earliest publication on her research is: R. Scott, 'On the Movements of the Flowers of Sparmannia Africana, and their Demonstration by Means of the Kinematograph', *Annals of Botany*, 17 (1903), 762-7.
[20] For example, see David Lavery, '" No more unexplored countries": The Early Promise and Disappointing Career of Time-Lapse Photography', *Film Studies*, 9 (2006), 1-8.
[21] For a full list see Jones, 178-83.

supply in the way of fees, however, is quite as sound as that of their male fellows'. As science continued to specialise and fragment, so new societies emerged specifically to cater for amateurs, including women. For example, the British Astronomical Association was founded in 1890 to provide an alternative to the Royal Astronomical Society and was advertised as 'open to Ladies as well as Gentlemen'. Several women, including Annie Maunder, were active in the Association.[22] However, here we can see a tension with women acquiring the accoutrements of scientific authority – fellowship of an elite society for instance – a tension that can be detected just as acutely in anxieties surrounding women in the laboratory, particularly when they make use of the 'dreadful instruments' of science.

The material culture of the laboratory presented special challenges to femininity and is a trope in the texts examined below. Around 1900, the laboratory was becoming a site for the display of virile experimentation and manliness, and of course we cannot understand scientific femininity without considering the construction of scientific masculinity at this time too. Obituaries and memoirs of male scientists published around 1900 present an illustration of the way in which the laboratory, particularly the physics and chemical laboratory, was presented as a masculine space where heroic qualities could be developed and displayed. Just one example: a reminiscence of James Dewar, who experimented on the liquefaction of gases in the early 1900s, highlights the 'personal courage' and 'iron nerve' that his work required. When 'an alarming explosion rent the air of the laboratory' Dewar 'did not move a muscle, or even turn to look', even though his 2 assistants each lost an eye in the course of the research.[23] It has been noted that there was more disquiet with women entering the laboratory for research purposes than for tuition. At UCL, for instance, at least one eminent professor was known for discouraging women in his laboratory for research purposes, plus female students were warned against seeking admission to chemistry classes as they could be 'scarred for life and have their clothes burnt off them as the men threw chemicals around'.[24] This is one reason why parallel facilities developed at some women's colleges. At Cambridge, chemical laboratories were built at Newnham and Girton Colleges in 1879 and

[22] Marilyn Bailey Ogilvie, 'Obligatory amateurs: Annie Maunder (1868-1947) and British women astronomers at the dawn of professional astronomy', *British Journal for the History of Science*, 33 (2000), 67-84, 77.

[23] Lord Rayleigh, Robert John Strutt, 'Some reminiscences of scientific workers of the past generation, and their surroundings', *Proceedings of the Physical Society*, 48 (1936), 216-41, 230. For further examples see Jones, Chapter 5.

[24] Carol Dyhouse, *No Distinction of Sex? Women in British Universities, 1870-1939* (London: UCL Press, 1995), 144.

the Balfour Biological Laboratory for Women opened in 1884. In London, both Bedford College and Royal Holloway acquired well-equipped chemical and biological laboratories in the late nineteenth-century too. Where facilities were shared, animosity to women persisted. With reference to Cambridge, Marsha Richmond has described a strong undercurrent of prejudice against the presence of female researchers in the laboratory, as opposed to students from Newnham and Girton who came for lectures and demonstrations, and quotes a male researcher recalling the 1890s:

> At that time women were rare in scientific laboratories and their presence was by no means generally acceptable - indeed that is too mild a phrase. Those whose memories go back so far will recollect how unacceptability not infrequently flamed into hostility.[25]

If the laboratory – conceived as a space for virile, active experimental science - held significance for masculinity, women's presence could be transgressive and threaten the credibility of the scientific knowledge produced there.

At the same time, women achieving success in scientific subjects continued to be a powerful symbol of women's intellectual equality with men. Any association with science in the early years of the twentieth century lent an air of progress and modernity, to women especially. A female scientist, especially a university-educated one, was both welcomed and feared as an advanced new woman embodying rationality, emancipation and expertise in a masculine sphere.

Ann Veronica

H.G. Wells published *Ann Veronica* in 1909; it is informed by his own experience as a science student at the Normal School of Science in South Kensington where he was awarded a first-class degree in Zoology by the University of London in 1890. The School became the Royal college of Science in 1890 and, in 1907, a constituent part of the Imperial College of Science and Technology, as did the Central Institution (later Central College of Technology), also based in South Kensington. Ann Veronica is a student in the biological laboratory of the fictional Central Imperial College, between Euston Road and Great Portland Street in London, taking an advanced course in comparative anatomy. In this text, science is

[25] Marsha L. Richmond, '" A lab of one's own": The Balfour Biological Laboratory for Women at Cambridge University 1884-1914' in *History of Women in the Sciences: Readings from Isis*, ed. Sally Gregory Kohlstedt (Chicago: University of Chicago Press, 1999), 235-68, 256.

represented as a beacon of clarity and rationality, qualities that are predicated tightly on the space of the laboratory. In the biological laboratory, Ann Veronica is liberated from the confusion that is the hallmark of all else beyond its walls. The laboratory's superiority of vision is symbolized even in its physical incarnation, at the top of the College building looking clear over a clustering mass of inferior buildings towards Regents Park. It is described as long and narrow, forming a quiet gallery of small tables and sinks, and pervaded by a thin smell of methylated spirit and sterilized organic decay. Along the side of the laboratory was a 'wonderfully arranged' series of displayed specimens.

> The supreme effect for Ann Veronica was its surpassing relevance; it made every other atmosphere she knew seem discursive and confused. The whole place and everything in it aimed at one thing – to illustrate, to elaborate, to criticize and illuminate…the room was more simply concentrated in aim even than a church…this long, quiet methodical chamber shone like a star seen through clouds.[26]

Students attended lectures and then entered this long laboratory 'and followed out these facts in almost living tissue with microscope and scalpel, probe and microtome, and the utmost skill and care…[27] This representation of an institutional laboratory has none of the eccentric chaos associated with the home laboratories of male experimenters; for example, the laboratory of Nobel prize-winning Lord Rayleigh at Terling was famously said by Kelvin to be held together with string and sealing wax.[28] By contrast it is controlled, efficient and directed to one aim: 'the coherent and systematic development of ideas.[29]

The laboratory has its own aesthetic imbued with rationality and purpose; the instructor Capes becomes almost a fetishized extension of this, just another specimen for Ann Veronica to examine. As she is working on a ribbon of microtome sections of the developing salamander, Capes comes to talk to her. She scrutinizes him as he is illuminated by sunlight, and just like the salamander sections, almost under the microscope. Ann Veronica notes

[26] Wells, 115-6.
[27] Ibid., 116.
[28] A.T. Humphrey, 'Lord Rayleigh: The last of the great Victorian polymaths', *GEC Review,* 7 (1992), 167-80.
[29] Wells, 117.

close-up the 'fine golden down' on his cheeks, the 'modelling of his ear', 'the soft minute curve of eyelid' and other, minute, bodily details.[30]

Here Ann Veronica is in the process of making the eugenically-sound choice of Capes as her sexual partner. Wells was a strong supporter of selective breeding and *Ann Veronica* is the story of a eugenic romance. Ann Veronica comes to view herself as part of processes she observes in the biological laboratory, of life as perpetually 'pairing and breeding and selection, and again pairing and breeding…[31] Despite Ann Veronica's strong passion for science, and her associated status as an advanced young woman, it soon becomes clear that science is no alternative to motherhood, no matter how emancipated the female scientist. Ann Veronica abandons her scientific pursuits once she partners Capes and the narrative resolves with her contentedly living a conventional life of domestic wifedom and motherhood. As Maroula Joannou has pointed out, eugenic alliances for Wells are based on a woman's submissiveness to a man who, in the evolutionary discourse that permeates the novel, is 'better stuff' than herself.[32]

Ann Veronica abandonment of science sends a clear message as to where women's true femininity resides; this message is reinforced by the dissonance in the text surrounding a woman using the material culture of the laboratory. 'All your dreadful scientific things' betrays an ambivalence to a woman in the place of experiment using the tools of cutting and dissection. In fictional texts – scientific romances – of the late nineteenth and early twentieth centuries, it has been noted that the it is often the laboratory which is the site of horror, danger and evil, as in Wells' 1896 novel *The Island of Doctor Moreau*.[33] Similarly, *Ann Veronica* is punctuated with textual references to cutting, dissecting and the work of the laboratory. These are central to descriptions of Ann Veronica's research and reflect the way that she organises her thoughts. For example, she remarks upon reading an article penned by her instructor/lover Capes that 'following his written thought gave her the sensation of cutting things with a perfectly new, perfectly sharp knife…'[34] These cold, precise and unemotional 'cutting' metaphors are the antithesis of the feminine, nurturing, motherly ideal

[30] Ibid., 130.
[31] Ibid., 125-6.
[32] Maroula Joannou, '" Chloe liked Olivia": The Woman Scientist, Sex and Suffrage' in *Literature, Science and Psychoanalysis: Essays in Honour of Gillian Beer*, ed. Helen Small and Trudi Tate (Oxford: Oxford University Press, 2002), 125-211, 203.
[33] Peter Broks, *Media Science before the Great War* (Basingstoke: Macmillan, 1996), 41-51.
[34] Wells, 125.

that Ann Veronica eventually embraces. Similar metaphors and language had been used earlier by Wilkie Collins to signify an evil and unnatural scientific woman.

Heart and Science

Heart and Science: A Story of the Present Time was published in 1883.[35] On one level, Wilkie Collins' novel is a conventional romance; however, it is also an interrogation of science - including gendered understandings of who should have access to it - and a powerful tract against vivisection. The main villain of the story, who tries to thwart 2 young lovers, is a female scientist: Mrs Gallilee. Mrs Gallilee is a clever and serious woman and it is her science that marks her out as ridiculous, duplicitous and a menacing, unnatural woman and mother. She is juxtaposed to the desirable heroine, the young, lovely, sweet and innocent Carmina who knows nothing of science, or indeed of anything. Unlike Ann Veronica, Mrs Gallilee is not university-educated; instead she has acquired her knowledge through attending scientific lectures, associating within expert male scientific networks and embarking on her own research. In this respect, Mrs Galillee's education is typical to that of women of science before the mid-1880s who were excluded from a formal university education. Entomologist Eleanor Ormerod (1828-1901), for example, was self-taught but became very influential in her field and gained an honorary doctorate from the University of Edinburgh in 1900.[36]

Throughout the text, Mrs Galillee's learning and use of educated, scientific language is a device to make her look ridiculous; her absurdity resides not in what she is saying, but in the that fact it is inappropriate for a woman to say it. Here, there is a clear warning about the dangers of a woman asserting scientific authority and expertise.[37] Collins makes this meaning transparent to the reader in his preface where he describes Mrs Gallilee's elicit acquisition of knowledge:

> On becoming acquainted with 'Mrs Gallilee' you will find her talking of scientific subjects… When 'Mrs Gallilee' wonders whether 'Carmina has ever heard of the Diathermancy of Ebonite,' she is thinking of proceedings at a

[35] Wilkie Collins, *Heart and Science: A Story of the Present Time* (UK: CreateSpace, 2014).
[36] J. F. M. Clark, 'Ormerod, Eleanor Anne (1828–1901)', *Oxford Dictionary of National Biography* (Oxford: University Press, 2004). http://www.oxforddnb.com.liverpool.idm.oclc.org/view/article/35329 (accessed 10 March 2016)
[37] See Patricia Murphy, *Science's Shadow: Literary constructions of late-Victorian womanhood* (Columbia: University of Missouri Press), 109-12.

> conversazione in honour of Professor Helmholtz… at which 'radiant energy' was indeed converted into 'sonorous vibrations'. Again: when she contemplates taking part in a discussion of Matter, she has been slyly looking into Chambers's Encyclopaedia, and has there discovered the interesting conditions on which she can 'dispense with the idea of atoms.' Briefly, not a word of my own invention occurs, when Mrs Gallilee turns the learned side of her character to your worships' view.

Again, it is Mrs Gallilee's experimental research and use of the material instruments of science which represent the menacing side of her nature and expose her lack of womanly compassion. Echoing Ann Veronica's 'dreadful scientific things', we are told that Mrs Gallilee became absorbed in science after her first husband's death, upon which she announced 'My mind must be filled as well as my heart. She seized her exquisite instruments, and returned to the nervous system of a bee'.[38] Similarly, she reveals that she 'sometimes dissects flowers, but I never trouble myself to arrange them', thus seriously challenging the Victorian ideal of middle-class womanhood.[39] By contrast, it is Mrs Gallilee's niece Carmina who embodies traditional feminine virtue. Patricia Murphy has pointed out how Carmina's character conforms to the teaching of Victorian sexual science as to women's nature. She has the rapid perception believed characteristic of her sex but lacks the ability to reason abstractly or deeply; in addition, she is portrayed as instinctive and childlike throughout. This representation reflects the Darwinian teaching on women's nature already discussed, in particular Spencer's theory that woman's evolution had stopped at a level below men's in order to conserve energy for reproduction; therefore, a woman's intellect was closer to that of a child's. As Carmina is depicted as an ideal woman, her fearful and uncomprehending reactions to science suggest that these are the appropriate responses of a woman. What's more, Carmina experiences a 'hysterical disturbance' which needs to be treated and so demonstrates the proper relation of woman to science – that of a passive object rather than an active agent'.[40]

Heart and Science is clearly antagonist to the idea of a woman of science; yet the same uncertainty as to whether a woman can embody scientific authority is apparent in a text

[38] Collins, 31.
[39] Ibid., 78.
[40] Murphy, 124-36.

published some 40 years later and which, on the surface at least, professes itself far more supportive of scientific womanhood.

The Call

The Call by Edith Ayrton Zangwill (1924) is usually classified as a suffrage novel.[41] It is set a few years prior to publication, in the years before World War 1 when the suffragettes were at the height of militancy, and part of the narrative concerns the heroine slowly converting to suffrage activism. Despite this, science is at least an equally dominant theme to suffrage and it is the detailed picture of a young female scientist that startles at the beginning of the book. Indeed, science is the heroine's key defining characteristic. The 'call' of the novel's title alludes not only to the heroine's call to the women's cause but also to her call to science. In the first years of the twentieth century, science was embedding its cultural and epistemic authority and acquiring the privileged status it has today. The choice of science as a calling for the heroine of *The Call* is therefore significant: the special standing of science, and its attachment to masculinity, makes Zangwill's heroine – like Ann Veronica – an advanced woman and the intellectual equal of men.

What makes *The Call* so valuable is that is a close, fictionalised biography of the physicist and electrical engineer Hertha Ayrton written by someone intimately connected with her – her step-daughter Edith Ayrton Zangwill. Hertha had studied mathematics at Girton College Cambridge, after which she trained in electrical and applied physics at the new City and Guilds Technical Institute at Finsbury as one of only 3 women among 118 men.[42] In the years that followed Hertha negotiated an eminent research career and became known within scientific circles and more widely. Her 1903 book on *The Hissing of the Electric Arc* contained new insights into the phenomena and it was this, as well as her later research on the formation of sand ripples, for which she won the Royal Society's Hughes Medal for Original Research in 1906. Hertha experimented at her husband's laboratories at the Central Institution, using male Central students as assistants. When her husband, Professor Edward Ayrton, died in 1908 Hertha lost her access to these institutional facilities and so set up her own laboratory at her home in London's Norfolk Square. Earlier, in 1902 Hertha became the first woman to be nominated for a fellowship of the Royal Society; despite having strong

[41] Edith Ayrton Zangwill, The Call (London:
[42] London Guildhall Library, *Records of Finsbury College*, 29,973. Hertha is listed as Sarah Marks.

support from sections of the Council, she was refused ostensibly because, as a married woman, she was ineligible. It was to be over 40 years later in 1945 when the first women were Fellows were elected.[43]

In *The Call*, Hertha becomes Ursula Winfield, a young woman chemist/physicist with a genius for experimentation. Ursula shares many personal and physical characteristics with Hertha and, more importantly, both women's scientific experiences coincide and it is possible to recognise key actors and events from Hertha's life. The first chapters of *The Call* are devoted almost exclusively to representations of Ursula as a scientific experimenter and essential to these is the laboratory.

Ursula's laboratory is in the topmost part of the house, hidden away in the servants' quarters in the attic. The symbolism here is quite potent. The laboratory is concealed, socially invisible (as servants' room usually are). This remote space, tucked away in the attic, seems to parallel the inaccessibility of science to women and the way that they worked at its margins. It also raises questions as to the appropriateness of science as an activity for a woman – why conceal the laboratory? - and echoes women's isolation and exclusion from the fellowship of elite societies. Ursula experiments here in a solitary way, on her own, yet by the early years of the twentieth century this was becoming an outdated way of working as science came under state funding and collaboration in institutional laboratories became the norm. Produced away from professional premises, scientific knowledge obtained in the home had the taint of amateurism, especially if discovered by a woman. The material culture of the laboratory is carefully presented and it is Hertha's research into the electric arc that is being described. The laboratory has a porcelain sink, gas taps and hooded fume cupboard, but all is dominated by a great hissing jet of flame that darts out between two, small dark carbons held in metal clamps. Ursula is surrounded by signifiers of electrical experimentation: thick black wires, a large frame of resistance coils, Bunsen burners… When the flame between the two carbons rushes with a vehemence and threaten to get out of control, Zangwill has Ursula shout: '"Bother". The ejaculation was energetic. At least this girl was human!'.[44]

Rather than a madwoman in the attic, *The Call* gives us a women scientist in the attic and,

[43] Joan Mason, 'Hertha Ayrton and the admission of women to the Royal Society of London', *Notes and Records of the Royal Society of London*, 45 (1991), 201-220.
[44] Zangwill, 10.

despite the text being the biography of an eminent female researcher, Zangwill seems a little ambivalent as to whether her woman scientist is mad too. Ursula is given some male, Frankensteinian traits: she is absorbed obsessively in her work, to the complete neglect of social duties and meals. Even when she takes the man who is to become her fiancé up to see her laboratory, she becomes so engrossed in her work that she forgets he is there and he has to creep away quietly. Ursula is also oblivious to danger: when her mother makes a rare visit to what she calls the 'infernal regions' of the house, drawn by the smell of Ursula's experimenting and to ask if gas is escaping, Ursula says no and lights a match to prove it. Science is antisocial in this depiction; it sits ill at ease with the duties of middle class femininity. As the mother complains, 'I have often told you that it really is not right the way that you shout yourself up here away from everyone. You might have a hump or a hare lip!'.[45] Despite the text being a call to equality, Ursula's experimentation is used throughout as a way to introduce levity and amusement. We are first introduced to her in a passage that produces comic affect only because the subject is a woman:

> From the topmost landing came the first unusual note. A door was ajar, and from the room within came a curious fizzling sound and a faint but still more curious odour. Some demented domestic appeared to be frying a late and unsavoury lunch in her bedroom… No servant in that house would have condescended to a shapeless, blue-cotton overall and, still less, to hideous, dark goggles, made still more disfiguring by side-flaps.[46]

This is further illustrated by a typical 'absent-minded professor' episode when Ursula interrupts a party held at her home:

> …a figure in a blue overall, with grimy hands and face, had suddenly appeared on the stairs. Pushing past some startled guests, the apparition had switched off a few unnecessary lights, with a murmured, 'I've got a lot of current on too – the main fuse will go' and then had rapidly disappeared.[47]

Uncertainty as to how to treat a woman in the laboratory seriously pervades the text, as does implicit anxiety at reconciling femininity with scientific pursuits. We are constantly being

[45] Ibid., 13.
[46] Ibid., 9.
[47] Ibid., 45. This account is almost identical to that in conventional a biography of Hertha: Evelyn Sharp, *Hertha Ayrton, 1854-1923: A Memoir* (London: Arnold, 1926), 156,

reminded that Ursula is young and beautiful (she does not need to do science because she cannot get a man) and her fiancé finds accompanying her into the laboratory troubling. He remarks that he prefers to meet Ursula in the park because she is 'less scientific, more human, more personal' - by implication more 'womanly' out of the laboratory than within it.[48] Here Zangwill seems unable to easily connect femininity with science, especially active and virile experimental work in the laboratory. Indeed, the problem of being a proper woman *and* a proper scientist were echoed in newspaper reports of Hertha's science. When she became the first woman to give a paper before the Institution of Electrical Engineers in 1899, the event was reported widely. One paper reflected that readers may think Mrs Ayrton's life a puzzle and rather odd, but went on to reassure

> But those who have the pleasure of her acquaintance declare that she is simply a most charming woman in her home life, a delightful companion in social affairs, and in every way a woman.[49]

The Call is a vivid recreation of elite networks of science in late Victorian and Edwardian London; in its depiction of scientific practice it deconstructs the mechanisms of women's inclusion and exclusion and reproduces Hertha's real relations with the Royal Society, fictionalized here as the Chemical Society. Ursula is only admitted to Society meetings with a male patron; she becomes the first woman to speak before the Society; her paper is published in the Society journal but a later one is refused due, she thinks, to disbelief that a woman had made these discoveries; and the Society refuses to amend it charters to admit women and allow her to become a fellow, so limiting her access to the Library and the latest developments in her field. The president of the Royal Society is particularly aghast at the idea of women and the move to try and get the Society's charters altered to admit women:

> Such a state of affairs would discredit the Society, reduce its meetings to frivolous functions. The introduction of frivolity was the reason always advanced by Professor Fleming against the admission of women to masculine institutions.[50]

The science narrative of the novel seems to argue for the inclusion of Ursula into scientific networks because of her genius – because she is *special*. Unlike the accompanying suffrage

[48] Zangwill, 131.
[49] Sharp, 137.
[50] Zangwill, 24.

narrative, it is not a call for access to all women; Ursula is not like other women because of her science. This is a major contradiction in the text which again highlights Zangwill's uncertainly over scientific womanhood and how to picture it. As we have seen, the idea of a scientific woman was no longer odd and women were accessing a university education in the sciences in ever greater numbers in the first decade of the twentieth century. Despite this, *The Call* betrays real hesitancy about what a scientific woman should look like. This ambivalence is also reflected in the resolution – or perhaps non-resolution – of the narrative. Ursula's fiancé returns from war paralysed and in a wheel chair and she decides to marry him and care for him. The romance is an incidental - almost a throw away - part of the book and its conclusion to the novel leaves questions. What happens to Ursula's science? Does her fiancé's disabled status mean Ursula avoids embracing full domesticity and the demands of matrimony and so can indulge her scientific calling? Or does marriage and caring for her husband require her to give up her research? At the start of the novel Ursula declares that she has no time for marriage as it would disrupt her work, yet at the end we are given no indication as to what Ursula's future life will be.

Conclusion

In the years around 1900 more women were benefitting from a university education and using it as pathway to acquiring research expertise and contributing to the development of scientific knowledge. Although numbers are small compared to men, it is clear that the idea of a female researcher was no longer an oddity, and that women were collaborating with their male and female peers more formally than previously the case when science was based predominantly in the home. Although women were still not accepted fully into the scientific community, and were required to negotiate spaces and relationships which allowed them to participate from the periphery, women were visible in science. For example, at the International Congress of Women held in London in 1899, Hertha Ayrton presided over the science section and many other female scientists, from the UK and further afield, gave papers and demonstrated a female face of science. Despite this, there is demonstrable unease at the idea of a woman scientist, especially one in the setting of the laboratory using her 'dreadful' scientific instruments for cutting, dissecting and experimenting. Even when the text is accepting of a woman scientist, as in *Ann Veronica* and *The Call*, there are implicit anxieties over a woman embodying scientific authority and a dissonance between femininity and science. It can be concluded, therefore, that the opening up to women of a university education in the sciences

in the late Victorian and Edwardian period did little to challenge the masculine colouring of both science and the scientist.