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Science and scientists in Victorian and Edwardian literary novels: insights into the emergence of a new profession

Nicholas Russell

Literary fiction has seldom been seriously considered as a mode of science communication. Here, I review novels from the 19th century canon of English literature in which characters either have, or aspire to have, substantive professional scientific roles to see what insights they provide into the practice of science in the Victorian and Edwardian eras. They reflect the historical transition of science from an intellectual hobby to a paid occupation, but also reveal that while a career in science became possible for a wider range of people, it seldom allowed these new entrants to undertake fundamental scientific research.

1. Introduction: scientists and novelists in the 19th and early 20th centuries

Science in a recognizably modern form developed in the 19th century and generated significant cultural change. Fiction writers picked up these developments, and scientific ideas permeate the work of writers in the literary canon. Nearly every leading 19th century writer was influenced by the positivist philosophy enshrined in the practice of science, and by the new knowledge produced especially in geology, biology and astronomy (Dale, 1989; Levine, 1988; Shuttleworth, 1984; Beer, 2000). The consequences of science (for good or ill), and hero and villain scientists stalk the pages of Victorian and Edwardian romances and early science fiction in the works of authors such as Verne, Conan Doyle, and Wells (James, 1994; Stableford, 1985). Science was a very big idea indeed and the work and personalities of real scientists received extensive coverage in newspapers and other periodicals (Broks, 1996; Brock, 2004).

Yet, in the surviving literary novels of the period, suffused with scientific thinking and scientific metaphors, scientists as major characters are rare, appearing only in a small number of canonical books by Eliot, Gaskell, Hardy, Gissing, and Wells (Haynes, 1994). This shortage of literary scientists seems surprising, given how liberally other professions are represented. This may reflect the small number of scientists who generated the new scientific ideas. Insight into the personality, activities and practices of actual scientists probably required personal acquaintance and extensive research. Given the small numbers of actual scientists it is not surprising to find that few authors had any acquaintance with them. The lack of scientists in the 19th century also begs the question of why, given the massive influence of science,

there were so few of them. Science did develop into an occupation, but the number of people practicing it remained small, even in the early 20th century (Meadows, 2004: introduction; Nye, 1996: ch. 1).

In this paper, I examine this shortage of professional scientists as a consequence of the way in which the profession developed in the 19th and early 20th centuries, and how that process is represented in canonical English literature. I also note how the emerging occupation of literary writing was subject to similar social forces and pressures to those operating in the professionalization of science.

The relevant novels span the Victorian and Edwardian eras, from Gaskell's *Wives and Daughters* and Eliot's *Middlemarch* (essentially historical novels set in the late 1820s and early 1830s, though written in the 1860s and 1870s), through books by Hardy set close to mid century, to works by Gissing and Wells in the late 19th and early 20th centuries. The science presented in Gaskell's and Eliot's books is an accurate portrait of the early 19th century practice of "natural philosophy", as judged from historical interpretation of actual scientific practice at the time. They show natural philosophy as a gentlemanly hobby rather than a professional occupation. Some of Hardy's characters are also natural philosophers but his main scientific protagonist, Swithin St. Cleve in *Two on a Tower*, hovers at the point where hobby was turning into occupation and the specialized elements of scientific practice consolidating into professional ethos. The scientific characters in the later novels by Gissing and Wells take up science as an occupational profession, an activity from which they hope to make a living.

Most of the scientific characters in Gissing and Wells are unsuccessful. This may reflect a truth about aspiration to a scientific career in the later 19th century, now potentially available to a larger group of lower middle class entrants. The depressing stories told by Gissing and Wells tell a sort of truth—a truth about an occupation failing to grow very fast because there was only a limited market for it. Science emerged late as a professional occupation and promised more than it could deliver. Other new occupations with strong scientific elements, such as engineering and reformed medical practice, offered more and better opportunities. Even paid careers in journalism and literature provided more scope, indeed they were important by-occupations in the portfolio of income-generating possibilities for professional scientists (Gay and Barrett, 2002).

2. The novelists of science and scientists

Writing was another of the range of occupations created or expanded by the complexity of 19th century society. It became a plausible way to make a living for more people during the 19th century with the growth of literacy and spread of industrial printing (Feather, 1988). Novelists emerged from a variety of backgrounds, the later ones taking advantage of the widening opportunities for university education designed (among other things) to increase the supply of people sufficiently educated to take up one of the new professional occupations.

But unlike science, literature did not become a profession, it was not an activity that required specialized education and training, provided specialized expertise through setting professional standards, or needed a strong ethos of service (Ben-David, 1972; Lubenow, 2002). Joining the elite literary cadre in the 19th century, however, did require an excellent education. Towards the end of the 19th century, such an education became increasingly accessible to members of the lower middle class, broadening the social origins of

professional authors, in parallel with widening access for the same group to scientific careers.

As the novels reflect changes to science and scientists, so the novelists who wrote them represent a parallel set of changes to the literary occupation. Earlier writers emulated the 18th century, gentry-based ethos of writing for its own sake. The writers themselves still tended to come from the middle and upper strata of society. Later writers could make a living from literature, and many of them (including those reviewed here) came from the lower middle classes and resented the persistent cultural assumptions about serious writing as an intellectual hobby for leisured gentry, when for them it was a harsh struggle to make enough money. The writers considered here all knew about science and scientists from either direct contact or close association, and their sympathy for the scientific life was further encouraged by severely rational or humanist life philosophies which they espoused.

Elizabeth Gaskell (1810–65) is both the earliest and most traditional author. She came from an established middle class background, although her family were dissenting Unitarians and holders of rational religious views. She married the Unitarian minister, William Gaskell, and spent her life as a clerical wife and mother in Manchester. While her literary career was critically and financially successful, neither Elizabeth nor William considered it her primary activity. She received only enough education (at a Warwickshire boarding school) to suit her for a middle class wife's role and had no inclination for self-improvement. But William was an enthusiastic natural historian and their extensive social network included a number of eminent engineers and university science teachers (Uglow, 1993).

Mary Ann Evans (George Eliot, 1819–80) was the daughter of a carpenter who took up one of the new professional occupations of the early 19th century, that of land agent. Mary Ann also received a middle class upbringing and boarding school education. She was ferociously intelligent and undertook extensive self-education in literature, language, philosophy and the emergent sciences, losing her religious faith in 1842 and substituting rational positivism as a humanistic creed. She found work in London as an editor for highbrow periodicals, where she became a confidante of literary intellectuals such as Herbert Spencer and G.H. Lewes, whose partner she became in 1853. Lewes wrote extensively on physiology and psychology and undertook investigative work under the guidance of Richard Owen. Through Lewes and his scientific friends, Eliot obtained insight into the scientific life (Ashton, 1996).

Thomas Hardy (1840–1928), one of the earliest of the new lower middle class writers, was the son of a builder who received a sound education, not of grammar school standard but sufficient to obtain an apprenticeship with a firm of architects. For nearly 15 years he practiced that profession in Dorset and London, soaking up all he could from the better educated journeymen around him and embarking on a ruthless schedule of self-education including a certain amount of science. Hardy shared a rationalist philosophy with the other authors here and in his late 20s contemplated going to university and becoming a clergyman, an occupation that would provide him with the time to write poetry, but instead took up novel writing, at which he became so successful that he was able to give it up in his 50s to devote the remaining 30 years of his life to poetry (Seymour-Smith, 1994).

George Gissing (1857–1903) was the intelligent son of a pharmaceutical chemist. His father oversaw his precocious education in the arts, literature and history (and some insight into the life of a journeyman scientist), until his death when George was only 13 years old. George had already accepted his father's rational agnosticism by that time. Friends of the

family provided funds to continue his schooling and he proved an outstanding scholar, winning a scholarship to Owens College, Manchester. He was caught stealing money to “save” the prostitute Nell Harrison and the disgrace ruled out any conventional professional career. Instead, he made a living as a private tutor and from (modest) earnings as a novelist and short-story writer. Just as Eliot had earlier bemoaned the social uselessness of educated women, Gissing lamented that the newly educated lower middle classes lacked the resources necessary to make use of their education in a suitably gentlemanly way (letter to Morley Roberts, quoted in Coustillas, 2004–5).

H.G. Wells (1866–1946) was the son of poorly educated parents, his mother having to leave home to work as a housekeeper. He received only an elementary education before leaving school at 13 to become a draper’s assistant. Like other children denied a formal education, he embarked on extensive self-education, making use of the huge library at Uppark House (where his mother worked) at weekends and during holidays. His progress allowed him to abandon drapery when he was 17 and become a teaching assistant at a grammar school. He was later awarded a state scholarship to train as a science teacher in London in 1884, although he left in 1887 without a qualification. Later, he achieved a first class science degree (in 1890). His teaching career was cut short by injury and he struggled to make a living from journalism and writing textbooks. In 1895, he broke through to critical and popular success with the scientific romance, *The Time Machine*. From then on he devoted himself to literature, left wing politics, polemical book writing, and journalism (Foot, 1995).

The two women authors (Gaskell and Eliot) were forced by their era and gender to educate themselves at an advanced level; there were no opportunities for women to obtain a formal university education so early in the 19th century. Thomas Hardy aspired to a university education but circumstances in the mid-19th century still made access for a lower middle class boy difficult (there were too few colleges and a severe shortage of scholarships). By the time of Gissing and Wells late in the century, people from such backgrounds had better access to universities because there were more of them and more scholarship support was available. This trajectory of wider access and increased opportunity for writers to live by their trade mirrored the transition in science from a gentlemanly hobby, to a potential career for a much greater range of people.

3. Gentleman dilettantes: natural philosophers in the drawing room

At the beginning of the 19th century, natural philosophy was a hobby practiced by anyone with the resources, time and leisure to pursue it. It was an open practice, anyone could take part, no special education, training or premises were needed (Jordanova, 1986). There were one or two paid government posts (Astronomer Royal for instance) and some departments of state needed to analyze raw materials and taxable products, or to undertake applied research for defense (Brock, 1996). But most natural philosophical research was strictly amateur so that leading enthusiasts tended to be gentlemen of independent means, or earning livings in professions with enough spare time to undertake research (Meadows, 2004).

The tradition followed on from the situation in the 18th century when, of the 106 people in Great Britain who made significant advances in scientific knowledge, the largest proportion were members of the gentry or aristocracy, with other significant groups being those practicing medicine (20 percent), engineering (15 percent), or members of the clergy (10 percent) (Cardwell, 1972: ch. 2). The last group was particularly significant in natural history well into the 19th century. Natural history was sanctioned by the doctrine of natural theology,

that the existence of God could be confirmed from the evidence of his designing hand in the natural world (Armstrong, 2000). Only one such clerical natural historian has a walk-on part in these novels, the rural Anglican clergyman Camden Fairbrother in *Middlemarch*. Gaskell provides a snapshot of another sort of natural historian devotee, the artisan insect enthusiast, Job Legh, a Manchester weaver in *Mary Barton* (1848). But it is gentry and medical men who constitute the largest groups of natural philosophers in the early part of the century and members of these groups constitute major characters in the novels of Gaskell, Eliot, and to a lesser extent Hardy.

Two members of the gentry group appear in Gaskell's *Wives and Daughters* (1866) and another in Hardy's *A Pair of Blue Eyes* (1873). The action of *Wives and Daughters* takes place in the Midland town of Hollingford in the 1820s/early 1830s and is therefore a historical novel with all the local Hollingford detail and color drawn from Gaskell's own upbringing in Cheshire and Warwickshire (Uglow, 1993). The two natural philosophers are members of local gentry families, the old established Tory, but almost bankrupt, Hamleys, and the grander Whig Cumnors. The heir to the Cumnor Estate, the young Lord Hollingford, is a more-or-less full time natural philosopher, allocating a great deal of his time and money to the study of nature, constructing his own domestic laboratory in the basement of the Cumnor family home and hosting receptions for parties of gentry colleagues to meet foreign scientific leaders. Specifically he entertains a leading French comparative anatomist on his way through England (the real Geoffrey St. Hilaire).

Hollingford and his circle undertake research but the group already deviates strongly from the classic pattern of gentlemanly behavior, which accentuated urbanity, fine manners, and wit above the pedantic, obsessive, and boring characteristics of dedicated scholars (Shapin, 1991). Hollingford's father exhibits classical gentlemanly manners, but the son and his natural philosophical friends are portrayed as bores, a group of jealous pedants. Making significant contributions to natural philosophy in the early 19th century already demanded dedication to a field of study and the peer group of players in the field rewarded performance according to high standards. The pedantic obsessions of the scholar were now essential, even among gentlemanly natural philosophers. The ideal of an open practice was breaking down. A degree of professionalism, in terms of special skills, dedicated learning and particular expertise was forced on this community even though there was still no formal training, and the activity was still not an occupation from which many people could make even a partial living.

The younger son in the Hamley household, Roger, is also an enthusiastic natural philosopher, a natural historian but he is clumsy, gauche and a poor conversationalist compared with his older brother Osborne, who is handsome, witty and academically able in the classics. Both sons go to Cambridge for a liberal higher education and much depends on their ability to achieve good results to ensure entry to a well-paid profession, and to increase their attraction for potential heiresses to restore the Hamley family fortune. High hopes for Osborne are dashed, he fails the Classics Tripos and takes up with an impoverished French woman. To everyone's surprise the younger, less glamorous brother, Roger, turns out to have high mathematical ability, indeed he passes out as Senior Wrangler (the highest performer in the Mathematics Tripos of his year), and therefore is automatically granted a college fellowship. This educational route was followed by many leading natural philosophers and scientists in the 19th century (Meadows, 2004), although in the earlier part of the century there were still very few occupational posts.

The Hamley family cannot afford Roger to remain a dilettante, and he can only continue to develop as a natural historian because Hollingford ensures that he is awarded funds to undertake a round the world specimen collecting trip. In the real world of the 1820s and 1830s

there was a great deal of scientific exploration taking place (Darwin himself was on the *Beagle* from 1832 to 1837) and Gaskell has Roger Hamley make his reputation, like Darwin, from the quality of the collections he sends back to England. But unlike the real Darwin, the fictional Roger has not the independent means to continue with his work. Gaskell died before she finished the book so we do not know what career she would have given him. Roger would have needed a paid career of some kind so he would have been forced to carry on natural history in his necessarily more limited spare time (Morris, 1996).

Hollingford and Roger Hamley were potential high achievers in natural philosophy, and that potential demanded commitment, in terms of acquiring the necessary intellectual knowledge and investigative competence. A more genuinely dilettante figure appears in Hardy's *A Pair of Blue Eyes*, the well-educated gentleman Henry Knight, mentor to the book's young architect hero, Stephen Smith. The book drew, among other things, on Hardy's own experiences as a church restoration architect in the 1860s, so the setting is essentially contemporary with the book's composition. The dilettante gentleman natural philosopher still existed and the fictional Knight exercises his taste for natural history on geological field trips to collect fossils. There is no suggestion that Knight wanted to be a leading natural history player, he is nominally a barrister working as a literary journalist. But the seriousness of his interest and his flexible free time put him into the category of those who could have undertaken serious natural historical research if he wished.

4. Medical researchers: professionals with enough time for natural philosophical research?

In the 18th century, medicine had been undertaken by two sorts of practitioner, liberally educated professional physicians and a variety of trades, including surgeons, apothecaries, midwives, and druggists. The physicians were a tiny minority drawn from the gentry and classic status professions (law, clergy, the military, and medicine itself), and would generally expect to treat only people of similarly exalted social status. The rest of the population were tended by members of the trades who might or might not be technically competent. Increasingly in the 18th century one specific trade became the dominant practitioner, the apothecary-surgeon and man-midwife (Loudon, 1986).

The history of the medical profession in the 19th century can be read as a fusion of the status professional physicians with the apprenticed apothecary-surgeons, evolving into a relatively uniform occupational profession whose practitioners aimed to provide a service to patients drawn from all social classes (Bonner, 1995). By the early 19th century, medical practice was to an extent based on rational analysis from investigations in anatomy, physiology and pharmacology. These disciplines had been pioneered on the continent, and in Great Britain they were taught especially in the Scottish Medical Schools and in the private medical academies in London (Bonner, 1995; Golinski, 1992). A minority of practicing physicians and surgeons undertook some scientific investigation themselves, while some undertook natural historical investigations in parallel with their medical careers, classic examples being Edward Jenner, who made significant contributions to smallpox immunization and the natural history of the cuckoo, and Gideon Mantell, the geologizing Sussex surgeon who documented the first dinosaur in 1824 (Cadbury, 2001).

The most famous fictional 19th century medical researcher is Tertius Lydgate in Eliot's *Middlemarch* (1871), and he is similar to his fictional contemporary in *Wives and Daughters*, Hollingford's surgeon, Mr. Gibson. Hardy also has a medical natural philosopher (a figure rather similar to Henry Knight), Edred Fitzpiers in *The Woodlanders* (1887). The Scottish

surgeon, Gibson, in *Wives and Daughters* is something of a new medical man, educated in Edinburgh and Paris with pretensions as a researcher; having published work in medical journals. His patients include both the Hamley and Cumnor families, and he socializes to an extent with Lord Hollingford because of their shared interest in natural philosophy. Hollingford sends Gibson interesting scientific papers and they converse on scientific matters. As a busy surgeon Gibson keeps up with scientific events, and has made some contributions in his youth, but he has not the time or resources to take anything more than a peripheral role in research. It was much harder to go on combining research with practice, but that is the route taken by Tertius Lydgate in *Middlemarch*.

Lydgate also espouses the new, materialistic brand of natural philosophy popular in France. Socially he is a distant relative of a member of the landed gentry, who acted as his guardian and paid for his education, but thereafter Tertius has to earn his own living. He chooses medicine and studies in London, Edinburgh and Paris, qualifying as a surgeon. He is keen to pursue medical research and hopes that employment as a provincial family doctor will provide him with a large enough income and sufficient time to undertake it. But Lydgate finds that making a living in the harsher occupational climate of the 19th century is harder than the status life of the 18th century physician. Building a medical practice takes more time and energy than he thinks and he compounds his difficulties by failing in the “business” side of his practice and by relatively early marriage.

He wins patients in his early days with high-profile treatments, but begins to upset them by requesting permission to do post-mortem dissections, and by failing to treat non-serious conditions in order to observe their progress. Tertius is also idealistic, preferring to treat the poor on the grounds of greater need. He finds it hard to develop the sort of relationship required of an ordinary practitioner in dealing with the gentry and other well-heeled patients. When he marries Rosamond Vincey, she wants him to build a practice and acquire the high social status of a physician. Her initial enthusiasm for the research side of his work rapidly evaporates when she sees that he seems to be losing patients through his “vampire” work. In the “Finale” in which Eliot summarizes how she sees the lives of her characters after the main action of the book is over, she has Lydgate die of diphtheria at the age of 50, having published only one monograph, on gout, a disease of wealthy patients. Rosamond remarries an elderly physician, a wealthy and successful medical professional of the old school.

In *The Woodlanders* Hardy’s Edred Fitzpiers is something of a rerun of the caddish Knight in *A Pair of Blue Eyes*. Fitzpiers is a gentleman, beneficiary of an expensive medical education in Germany and elsewhere on the continent, who has come to practice medicine in the rural area where the novel is set. He does not try all that hard to build his practice, being more interested in continental philosophy and dabbling in pathological research, using tissues from his dead patients. One fairly prominent plot line involves him purchasing the skeleton of a patient while she is still alive, so that he can dissect her when she dies. The ordinary country folk look on him with considerable distaste, echoing Rosamond Vincey’s attitude to Lydgate’s research. Fitzpiers eventually buys a larger practice in a Midland town when he receives a legacy. It is not clear whether he can be bothered to build and maintain it. This “scientific” figure in Hardy still conforms to the old pattern of undertaking research as a rather unfocused hobby, and needs income from some other source to sustain it.

5. The engineers: professionalism demands a liberal education and an apprenticeship

Roger Hamley’s mother, in *Wives and Daughters*, casting about for a possible career when he appeared “dull” and “practical”, thought civil engineering might suit him. Gaskell

demonstrated that she also understood the professional worlds of engineers in her novella, "Cousin Phillis" (1865). Engineering was one of the new occupational professions of the 18th century, originating in the canal projects of the 1760s and then extending to steam engine design and machine development in the 19th century. Engine and machine work in the 18th century had been undertaken by millwrights lacking polite education. Such men were transformed into civil engineers because canal projects needed to be presented in Parliament to obtain enabling Acts. John Smeaton (himself a gentleman rather than an artisan) was one of the pioneers who founded the first body to represent engineers, the Society of Civil Engineers in 1771. He modeled it on the gentry special interest clubs of the time, notably the Royal Society and it functioned as a combined social club and learned society rather than a professional organization. By the end of the canal boom in the second decade of the 19th century, the Society was more or less moribund and replaced in 1818 by the Institution of Civil Engineers. This was a "qualifying association," dedicated to technical education and professional competence. Even so, it barely survived through its early years, but came into its own in the 1840s as demand for engineers increased in the railway boom (Buchanan, 1989).

Entrants to engineering, as to other new professional occupations, originally came from a wide variety of backgrounds. Samuel Smiles, composer of eulogizing biographies of pioneer engineers, chose to accentuate those like George Stephenson who had come from humble backgrounds (Smiles, 1859). In doing this, Smiles perpetuated the idea that engineers were of inferior social birth and needed only craft training. But the social class emphasis of the original Society of Civil Engineers, and the expensive apprenticeship schemes for qualification for the Institution of Civil Engineers, must have narrowed entry to the profession to those who could afford apprenticeship premiums. Indeed, analysis of the elite membership of the Institution of Civil Engineers in the 19th century shows that where occupational background is known, 15 percent came from the gentry and status professions, while only 3.5 percent came from artisan backgrounds. The biggest group (63.4 percent) came from middling backgrounds such as public servants, small businessmen, and the occupational professions. One quarter had some form of university education (Harper, 1996). Harper draws attention to the irony that fictional engineers, such as Henry Clavering (Trollope, *The Claverings*, 1869) or Edward Holdsworth in Gaskell's "Cousin Phillis", both come from middle class backgrounds while the supposedly factual representations in engineering biographies by Smiles, suggest the low social status of entrants to the profession. The novels are closer to reality than the biographies.

There are three characters in Gaskell's "Cousin Phillis" with "engineering" aspirations. Edward Holdsworth is well bred, well educated, has served an apprenticeship in an engineering shop, and has been abroad to Italy on railway construction business. At age 25 he is the project engineer responsible for building the line from Hornby to Eltham. The narrator, Paul Manning, is employed as Holdsworth's clerk. He is not apprenticed as an engineer, although from his position he picks up a great deal of technical know-how. Paul's father is an inventive but poorly educated Birmingham mechanic, a proto-engineer in the Smiles mould. He is an artisan foundryman who became friendly with Holdsworth when the latter was a gentleman apprentice in the company forge shop. Holdsworth has considerable admiration for the older Manning as a self-educated workman with little formal education. The three men share a range of professional values and attitudes around technology, a relatively subtle portrayal of the mixture of skills and backgrounds in craft practice and engineering at the time.

Gaskell portrays another engineer in *Mary Barton* (1848). Jem Wilson (a central character as a suspected murderer) is the son of a weaver but employed by an engineering firm

making, installing and maintaining mill machinery. It is not clear what level of education he has received or what form of apprenticeship he may have served but he is inventive and proves a good manager. He and Mary Barton emigrate to Canada together at the end of the novel, where he finds work as an instrument maker in an agricultural college. In modern parlance, Jem looks like a technician. In Gaskell's industrial world, while civil engineering projects certainly need educated professional engineers, the technology of industrial production remains open to artisans with craft skills.

By the mid-19th century the new, rational, science-related occupations of medicine and engineering were growing fast, their professional standards and practice controlled by self-regulating associations, serving expanding markets for their expertise and providing reasonable incomes for many practitioners. But science as a professional occupation lagged behind. The market for the highest status science, pure research into abstract explanations of natural phenomena, remained small. By the mid-19th century, self-educated enthusiasts from the lower middle classes aspired to scientific careers, but pure research remained largely the preserve of gentlemen or the small group of university teachers drawn largely from the middle and upper classes. We encounter a lower middle class aspirant in the person of Thomas Hardy's young astronomer, Swithin St. Cleve.

6. Swithin St. Cleve, Hardy's lower middle class character on the cusp of a modern scientific occupation

Swithin St. Cleve in *Two on a Tower* (1882) wants to be an astronomer (he dreams of becoming Astronomer Royal). Hardy deliberately set out, as he made clear in a letter to Edmund Gosse, to make science the vehicle for plot and characterization in this novel (Seymour-Smith, 1994; Pinion, 1976). The chief protagonists are the aristocratic Lady Viviette Constantine and the much younger Swithin, who has rigged up an observatory on a tower on the Constantine estate. Swithin's mother, of humble farming stock, married a well-bred clergyman and the gentry side of the family provided funds for Swithin to attend the local grammar school. He develops a passion for astronomy and is able to fit up a primitive observatory on the tower and devote himself to nocturnal observations.

Swithin is testing a theory about the variable stars, the idea published by the American astronomer E.C. Pickering in 1881 (Seymour-Smith, 1994). Swithin's fictional hopes of advancement are dashed when he reads the real Pickering's journal article just as he is about to send off the manuscript of his own paper. He is beaten because advanced observations cannot be made with primitive equipment. Without either institutional support or independent means, Swithin's career hopes would have died there. But romance comes to his rescue and the wealthy Viviette buys his instruments for him. Her attachment drives her to assist him in making observations thus allowing Hardy to include detailed accounts of scientific shop-work, including how to make accurate and consistent observations and record them, the purpose and structure of scientific papers, and the significance of priority claims.

Swithin's enthusiasm and promise are spotted, but in the old-fashioned way of class and kinship connections, when a great uncle on his father's side leaves him a legacy to pursue astronomical research. He uses the money to fund a trip to the Southern Hemisphere, joining an expedition observing a transit of Venus. While scientific and professional competences are important, Swithin can only take part in the expedition because his connections allow him to finance himself. It is unclear from Hardy how Swithin's career might develop. While he wants to be an astronomer and it may be that an academic opportunity will emerge, Swithin's progress actually depends on the older gentlemanly framework, and

as in Roger Hamley's case it seems unlikely that he would have the resources to survive as an unpaid devotee.

7. The new professionals: science as an occupation

While the emergence of science as a paid professional occupation during the 19th century was sporadic and uncertain, we have seen that other new professions had begun in the 18th century and increased in number during the 19th century (Holmes, 1982; Larson, 1977). Technical competence and quality of service to clients became the hallmarks of new professions like architecture or surveying. These qualities had not been central features of the long-established status professions, the law, the church, the army, and the practice of the physician (Elliot, 1972). Here, social ease with their gentry clients had been more important for practitioners than attested competence.

As the experimental study of nature became more sophisticated in the second half of the century, it needed well-equipped laboratories and acquired procedural rules. Partly because of the need for resources and training, and partly to gain control over what could and could not be defined as "science," it gradually became a closed activity, in which only those with proper professional accreditation could operate (Winter, 1997, 1998: ch. 11). This gradual professionalization is already clear in Gaskell and Hardy. Their characters are natural philosophers, but specialization, training and equipment are becoming more important and funding these activities is becoming a central issue. Ideally, the professional cadre needs salaries, laboratories, and equipment. But there has to be a market to allow this to happen and the evidence below suggests that such a market failed to develop.

While Whewell had coined the word "scientist" in 1832 to describe the members of the newly formed British Association for the Advancement of Science (BAAS), the gentlemen, professionals, and businessmen who comprised the membership resisted using the term. Analysis of the national census returns during the 19th century for individuals with established scientific reputations shows them variously recorded as "landowners," "teachers" (academics in universities), or "civil servants" (Higgs, 1985). To practice science was still to satisfy liberal and educated curiosity, and perhaps discover evidence for God in the laws and theories of nature (Golinski, 1992; Yeo, 1993).

But the founders of the BAAS wanted to professionalize science by confining its practice to accredited experts and proselytizing for a career structure for scientists. They tried to take control of the agenda for science and use it to further a set of conservative religious and political attitudes. The leaders aimed at the formation of a scientific clerisy, a moral force with the aim of influencing governance (Morrell and Thackray, 1982; Winter, 1997). They remained convinced that the proper work of science was to develop abstract, explanatory theories, even if they had problems showing that such purity was superior to the application of science in medicine or engineering. The BAAS was warned in 1834 of the undesirable consequences of wider public education in science because people would become more interested in applications and facts, and take less interest in the proper role of science, the development of theoretical explanations (Yeo, 1993).

The activities of the BAAS and others led to a high public profile for natural philosophy through public lectures and demonstrations and by educational and popular literature (Yeo, 1993; Golinski, 1992). This greatly extended the existing market for scientific lecturers, demonstrators and writers which had begun in the 18th century, allowing more of them to make a living from science. But this "commercial" practice of science was still looked down upon by the gentlemanly elite (Golinski, 1992; Smith, 1998). Thus, Joule found it expedient

to stop publishing his work in the journals of William Sturgeon, a showman who encouraged the work of inventors, and establish himself in the pages of the long established *Philosophical Transactions of the Royal Society*; to cease engagement with useful scientific application and to investigate the laws of nature instead (Smith, 1998).

In science, the focus was on the pursuit of knowledge for its own sake, independent of any market demand. A small core of scientists largely succeeded in this aspiration, centered round a small number of scientific lecturing posts and chairs in universities and colleges. They provided a model that many of their students aspired to follow. For most of these students, such freedom was not possible, neither government nor industry would fund enough professional scientific positions. Most of the work of the late 19th and early 20th century was scientific grunt work, with school teaching and industrial analysis the most obvious choices. The lower middle class boys portrayed by Gissing and Wells often find they are limited to such humble activities, and are not best pleased as a result.

8. George Gissing: *Born in Exile* and the bitterness of failed scientific aspiration

By the 1850s, there were still rather few people being paid to do science but by the end of the century many scientists were paid, often at a school, college, or university. The model for a salaried science profession came from Germany and the cheerleaders for a similar English model were Huxley, Tyndall and fellow members of the London X-club, building on earlier BAAS lobbying for a state-funded clerisy of scientific intellectuals. But, the problem for any occupational model for science was the lack of demand for scientific knowledge and services from the state or industry. This meant the number of salaried posts was always smaller than advocates hoped (Meadows, 2004). The majority of paid scientific jobs were either in analysis for the chemical or chemical-related industries, or in school teaching. Heroes with a scientific bent in any of the novels by George Gissing or H.G. Wells found their horizons limited to these sorts of opportunity.

Several bright members of the lower middle class in the later 19th century discovered that education removed them from their own class while failing to fit them properly for life higher up. In *Born in Exile* George Gissing's university-educated, lower middle class hero, Godwin Peak, gnaws away at the class limbo into which he has been thrust. In this book and in several by H.G. Wells, the difficulties of class mobility are explored in the context of science education and careers. As *Born in Exile* (1892) opens, Godwin Peak is attending a prize giving ceremony at a northern college in 1874. The lower class Peak has a friend from a similar background, Earwaker, and two rivals from gentry backgrounds, Buckland Warricombe, a pointedly progressive and atheistic young man from a conservative Anglican background, and the beautiful and theatrical Bruno Chilvers.

The event exposes Peak's resentments about the privileges of the gentry, and the shame at his own humble background. The final straw is the decision by his uncle to open a café outside the college, social death for the snobbish Peak who feels he must withdraw and transfer elsewhere. On a visit to an old employer, Moxey, he meets Moxey's nephew and niece, Christian and Marcella, who are both well bred, though to Peak's surprise Christian works for a chemical manufacturer, Bates Brothers, in Rotherhithe. This provides him with an example of a paid scientific job and Peak determines to make his last degree year in the sciences. He negotiates a transfer and continued bursary support for study at the School of Mines in London and completes his degree there.

The story then picks up ten years later. Peak is now employed by Bates Brothers, Christian Moxey has left but still pursues his own scientific interests in a domestic laboratory

(which Peak much envies). Though doing applied analytical work to make a living, Peak's real interest is in geology and he accumulates savings to give himself a year off to undertake some "proper" research. His geological interests have kept him close to the ongoing debates about science and religion and he uses Earwaker, now a radical journalist, to help him publish a diatribe against orthodox Christianity.

Peak then encounters Warricombe's sister, Sidwell, in Exeter while en route for a holiday in Cornwall and is deeply smitten. He also runs into Buckland and is invited to spend time at the Devon family estate, becoming better acquainted with the Anglican father who is also a gentleman geologist. Peak much envies him his collections, library, and opportunity to do whatever scientific work he pleases. But not only is the old man an old-fashioned scientific devotee, he is also religiously conservative, as are his wife and daughter. Peak conceives a wild scheme to retrain as an Anglican cleric so that he can argue for the orthodox conservative position in religion-versus-science debates. He hopes this will help his courtship of Sidwell, while providing him with a comfortable and not-too-taxing career so that he can conduct scientific research in his spare time. His unhappiness with the applied science of the chemical business is so great that he is prepared to commit a major act of hypocrisy by denying his anti-religious attitudes and claiming to be conservatively God-fearing instead.

Needless to say, the plan unravels and Peak once again becomes a poorly paid analyst living out a gloomy life of poverty in a career that he dislikes. Then Marcella Moxey dies and leaves him a legacy. He has an escape route into shabby gentility. He determines to live abroad, to seek intellectual company and write, free from the lethal constraints of the British class system. Such a hermit's life proves hard and Peak eventually dies of malaria in a Vienna hotel room.

9. Godwin Peak's problem: pure research as aspiration, chemical analysis for a living

As we have seen, it was difficult to be paid as a scientist in the early 19th century. Charles Babbage complained vociferously that there was no such thing as a scientific career in 1830 (Yeo, 1993) and Norman Lockyer was still declaring in 1873 that "there is absolutely no career for the student of science as such in this country. True scientific research is absolutely unencouraged and unpaid" (Cardwell, 1972: 151). Even in the last quarter of the century, many employed scientists needed additional income from a portfolio of freelance activities (Brock, 1996; Gay and Barrett, 2002; Meadows, 2004). Despite his fame as the co-discoverer of the theory of evolution, Alfred Russell Wallace had to make his living from journalism, since he never obtained a paid scientific post (Raby, 2002). Sir William Crookes, famous as a leading experimental chemist, electrician, and active spiritualist, conducted all his scientific investigations in his own domestic laboratory. His income came from extensive business interests and from publishing and editing successful trade magazines (Brock, 2004).

It is clear that it was difficult to turn science into an occupational profession in the later 19th century because there was no real market for it (Russell et al., 1977). But in addition, many elite scientific practitioners resisted the occupational model, they did not want to sell their expertise in the market. That did not provide the freedom to explore fundamental theory which they demanded. They therefore clung to the idea that science should be a status profession, building on the leadership in natural philosophy that had

arisen from earlier gentlemanly practice. Thus although J.D. Hooker held a good occupational post (Director of the Botanic Gardens at Kew), he had a clear vision of science as a status activity. He saw the scientist as first and foremost a gentleman, his reputation springing from his personal behavior and social position rather than his scientific qualifications (Bellon, 2001).

But despite this clear emphasis on fundamental theory as the point of science, the BAAS and other science pressure groups made extensive use of the rhetoric of utility, claiming that science should be supported because it was essential for industrial technology. But few of the scientific elite wanted anything to do with application or engineering themselves, nor did industrialists see much need to employ manpower concerned with theory at the expense of industrial practice (Argles, 1964; Summerfield and Evans, 1990). The fictional Godwin Peak became a disappointed chemical analyst, undertaking tedious quality control work.

The gentlemanly ethos that Hooker and others tried to preserve was constantly undermined by the pressures of specialization. Fragmentation threatened to create a body divided against itself although the BAAS, and later the magazine *Nature*, both tried to present a unified public face for science. A *Nature* editorial in 1879, "The claims of science" (quoted in Kjaergaard, 2002) presented a eulogy to the self-denying pursuit of true natural knowledge by a group of disinterested savants who worked only for the good of science and society. But the unity presented by the BAAS was undermined by the stratification and hierarchy of the organization itself (Rudwick, 1985: ch. 2), while the house journals of science contained acrimonious professional disputes (Kjaergaard, 2004; Barton, 2004). The BAAS subject disciplines were arranged in a distinct hierarchy in which the theoretical disciplines of mathematics and physics always came top, with the social sciences and engineering (classic applied activities) at the bottom. Many in the scientific community despised the public's admiration for industrial machines and engineering inventors (Kjaergaard, 2002).

The case of geology is something of an object lesson in the dominance of purity over application. The practical problems of the mining, road and rail industries were solved by occupational trades such as canal building, coal prospecting and viewing together with drainage experts, mineral assayers, quarrymen and civil engineers, not by scientific geologists (Porter, 1977). Geology remained the preserve of gentlemen devotees for a long time (O'Connor and Matthews, 1976). For instance, the 1929 obituaries of Sir William Boyd Dawkins recorded at length his academic contributions but his work as a consultant for the water, tunneling and mining industries received much briefer coverage (Tweedale, 1991). Poor Godwin Peak's class envy in the context of his chosen field of geology turned out to be fully justified. Being paid to work as a geologist remained a near impossible dream for an ordinary person until many years after Peak's fictional and Gissing's actual deaths.

10. H.G. Wells: science becomes an occupational profession but his protagonists, like Wells himself, fail to thrive in the career

Most of Wells's literary novels were written between 1900 and 1915 and in several of them, scientists or proto-scientists take leading roles, notably *Love and Mr Lewisham* (1900), *Tono-Bungay* (1909), and *Ann Veronica* (1909). *Love and Mr Lewisham* is about a failure of ambition, ostensibly caused by personal weakness, young Lewisham's sexual desires. These can

only be quenched by early marriage whose distractions interfere with his studies. The book opens in the late 1880s with Lewisham as assistant master at a small provincial school. He is ambitious and sets himself a punishing schedule of study, drawing up an ambitious *schema* or life plan, with the ambition to rise to the top of some profession. But Lewisham abandons his austere schedule when he meets the typist Ethel Henderson and is sacked from the school, although he manages to begin the next phase of his planned development, attendance on a government grant at the Normal School for Science in South Kensington. While opportunities to pursue higher education at government expense are new and liberating, they are also directional and constraining. The end product expected is secondary school science teaching—not scientific research.

Lewisham notes that many of those who do better than him at the Normal School are comfortably middle class, not struggling on meager scholarships, a gentler expression of the class envy that eats away at Gissing's Godwin Peak. Lewisham agrees to marry Ethel and under these circumstances his small bursary and her failure to find much work produce financial pressure on top of loss of study time, leading to personal tensions and worsening exam performance. Things come to a head when Ethel announces that she is pregnant. At that point Lewisham rips up his schema and accepts that he will have a modest career and cannot aspire to any form of professional life, even one as humble as secondary school science teaching.

Tono-Bungay is told as an autobiographical story by George Ponderevo, a young man apprenticed to his retail pharmacist uncle Teddy. In his spare time, George takes Science and Art Department classes and exams. Teddy goes bankrupt and is forced to sell up and work in London, but George stays on apprenticed to the new man, taking more Science and Art Department courses and passing the qualifying exams of the Pharmaceutical Society. He is offered two scholarships, one for the Pharmaceutical Society and one for a scientific technology degree at the Consolidated Technical Schools at South Kensington. The latter is more to his taste as it will lead to engineering, which is where he believes his real interests lie.

Once in London, he only completes two years of the course before going off to help uncle Teddy with his new patent tonic, marketed as "Tono-Bungay," a harmless mix of known stimulants. George is put in charge of production and makes some engineering and industrial packaging improvements, taking out several patents. He then drops out of active participation in the firm to follow his own interests in engineering; developing gliders, balloons and heavier-than-air flying machines. He publishes theoretical papers and builds and tests prototypes. The income from Tono-Bungay has bought the freedom and time essential for good scientific work. George is effectively in the position of a gentleman devotee but as a Wellsian and lower middle class hero, he does applied technological work, not pure research. He has the gentleman's resources but not the gentleman's taste for the abstract. George is stimulated by the need to be useful, rather than the desire to do fundamental work.

Ann Veronica Stanley is another fictional devotee of science who starts down the road towards a scientific career with an education at a minor college for women, topped off with a final year at a more prestigious institution glossed as the Central Imperial College, another version of the South Kensington Normal School. The plot of *Ann Veronica* focuses on her problems in breaking away from a stereotypical female role. She eventually marries an older mentor, the zoologist Capes, abandoning any ambition to become a scientist herself and settling for a domestic role with a scientist who re-invents himself as a playwright. Ann Veronica is allowed the traditional female escape route through upwardly mobile marriage, rather than the graft of making a career. If she had not escaped, Ann Veronica's probable fate, even with

a good degree, would have been school teaching. Even technical support roles within science were not open to women until the 1930s.

11. The new educational climate in the later 19th century

Where did the educational opportunities exploited in the 1870s and 1880s by Gissing and Wells and described in the stories of their fictional counterparts, Peak, Lewisham, Ponderevo, and Stanley, come from? They did not exist in the worlds of Gaskell, Eliot, or Hardy. Cardwell (1972) has outlined the main steps in the development of science education and finds that these were driven by vocational demands. In 1853, the government set up a Department for Science and Art on the South Kensington site purchased with the profits from the 1851 Exhibition. The new department was designed to ensure that British industrial domination was maintained in response to keen competition from Germany and France. It was responsible for providing secondary education in technical, scientific, and modern subjects, although its creation did not imply much direct state intervention; it merely provided encouragement and set up a system of national examinations. The department was not alone in providing such opportunities; it was soon joined by industrial pressure and self-help organizations such as the Royal Society of Arts (RSA) and the City and Guilds of London Institute (CGLI). This vocational emphasis was not to the taste of those teaching academic science in the universities and represents an additional source of tension between the scientific elite and their student body.

The exams and curricula were taught all over the country at Mechanics Institutes, in libraries, in the evenings at schools, or by self-tuition at home. The RSA and CGLI schemes gradually displaced the Department for Science and Art system in the latter part of the century, and had more trade and technical emphasis. Wells and his fictional heroes were all beneficiaries of this new exam system. During the 1850s and 1860s, there had been relatively little uptake of the increasing number of science and technology places offered by various colleges. The key reason for this, repeatedly identified at the time, by many pundits and two extensive Royal Commissions (Devonshire 1872 and Samuelson 1884), was the lack of proper preparation at school in the sciences to enable students to benefit from higher education.

Training the necessary science teachers became a prime objective. The government was persuaded to fund colleges dedicated to teacher training, so-called "Normal Schools," and especially those for science teachers. The under-recruiting South Kensington colleges were all re-designated Normal Schools in 1881. One of the leading lights in the drive to improve science education was T.H. Huxley, who had been appointed lecturer in natural history at the Government School of Mines in Jermyn Street in 1854. Huxley developed a vision of science education for specialized students of science. But he could not put this into practice at Jermyn Street because he had no laboratory or seminar room.

Some parts of the Royal School of Mines (re-designated from the Government School of Mines in 1863) moved into new buildings at South Kensington in 1870/71. At first Huxley did not see the South Kensington site as much of an opportunity but he eventually tried out his didactic ideas in the context of teacher education running a pioneer summer school for trainee teachers in 1871. The 1870 Education Act produced a continuous stream of subsidized students for the Normal School, including of course H.G. Wells. In the school's heyday Huxley delivered a morning lecture with lots of blackboard work, and then left his assistants to run the practical classes where the truths of his exposition would be

demonstrated by the students undertaking their own observations and experiments (Forgan and Gooday, 1996).

12. Conclusion

Scientific research, which had begun as an open, widespread (if gentry-dominated), unpaid hobby became during the 19th century a closed, fragmented set of salaried specialists located in a relatively small number of college and university departments. This academic elite was still dominated by the upper middle class and clung relentlessly to a vision of science as a knowledge-generating, status activity. While it adopted rhetoric of application and industrial utility, the elite showed little interest in making these activities the core of a new occupational profession, despite the fact that their student population was provided by schemes designed to improve applied science and technology. To the extent that science-based occupational professions did grow, they were in medicine and engineering. The elite scientific preference for sticking to a status ethos was reinforced by the failure of industry to provide a market for an occupational profession, and undermined by the lack of substantial sums of public money for pure research (Meadows, 2004). Growth in scientific education nevertheless went ahead and led to an emergent cadre of scientifically educated members of the lower middle classes whose horizons were effectively limited to school teaching or industrial analysis.

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