PLANT BREEDING AND INTELLECTUAL PROPERTY BEFORE AND AFTER THE RISE OF MENDELISM: THE CASE OF BRITAIN

BERRIS CHARNLEY & GREGORY RADICK

How, if at all, did intellectual property (IP) arrangements in Britain in the decades around 1900 shape the debate there and then over Mendelism? Focusing on plant breeding, this paper offers a preliminary analysis. Along the way it aspires to make a start on two related problems. One is to uncover the methods used to protect the value of new plant varieties in Britain in the period before the establishment, in the early 1960s, of the International Union for the Protection of New Varieties of Plants, or UPOV. (On the contemporary American plant IP situation, see Kevles, 2007). The other is to explore the potential for understanding why Mendelism became as successful as it did – one of the outstanding questions in the history of the biological sciences – by attending to moments when debate over Mendelism overlapped with concerns about plant variety IP. In keeping with these aims, the paper has two parts. It begins with an overview of IP and plant breeding in Britain between 1870 and 1930, then turns to consider how some of the arrangements surveyed came to matter in the debate over Mendelism. Two moments on either side of the debate are dwelt upon, each involving a different plant breed: the first in the early 1900s, involving a variety of pea called *Telephone*; the second in the mid-1920s, involving a variety of wheat called *Yeoman II*. The analysis aims to show that, by the end of the period discussed here, plant variety IP arrangements were a vital part of a system functioning for the mutual protection of Mendelian products and Mendelian principles.

IP in Plant Varieties in Britain, 1870-1930

The most serious commercial threat to breeders attempting to profit from their original varieties was the problem of synonyms: the same or very similar plant varieties sold by seed dealers under different names, often without the originator's permission. The practice was essentially piracy. On the whole the market was unregulated, so the sale of synonyms could be quite widespread. Furthermore, the hierarchical structuring of the market meant that although less established breeders could be "discouraged" more or less effectively from the practice, better established breeders sold synonyms with relative impunity (Palladino, 2002, p. 42). But even in these cases, there were various informal means of protection; and there gradually emerged an increasingly organized set of instruments and even legislation to deal with synonyms and other problems such as deliberate mislabelling and the sale of inferior seed. We shall first describe some informal practices which persisted throughout the period, then look at some changes in formal structures.

In Britain at the time there were three big seed firms, Gartons, James Carters & Co. and Suttons. The literature produced by these companies, including seed catalogues and farmers' guides, played an important role in protecting new varieties from piracy. Carters in particular produced lavish yearly catalogues and farmers' guides, often with photographs that sometimes even showed how different varieties compared with each other in order to aid identification. In general the reputations of these companies served as a guarantee and a means to keep buyers coming back to the same source of seed; this promotional literature was one way of maintaining these hard-won reputations. Carters were particularly keen to trade on their name and position as suppliers of seed to the Royal Household – a distinction they proclaimed in much of their advertising literature. Another set of means for securing identity, and so protection, was the use of sacks and seals. Seed was often sold in sacks with the name of the seed variety written on them, and sometimes these sacks were also sealed. The sealed sacks would then be supplied directly to the purchaser by post, further reducing opportunities for tampering. Even in the nineteenth century there was an important institutional dimension. Informally, the Royal Horticultural Society provided some protection against synonyms. The Society ran several committees which rated new varieties, awarding certificates based on quality: first class, second class, botanical

commendation and commendation. Awards of these certificates were reported in the Society's journal. Notice of awards would often be made in firms' advertising material, where they functioned as a warrant to the originality and quality of a new variety. These certificates were augmented by the awarding of prizes at flower shows (the most famous of which, the Chelsea flower show, is still running). Another institution, the Royal Agricultural Society, also ran some trials of new varieties, publishing the results in its journal. Readers would often write in with the results of their own trials. The Royal Agricultural Society's shows also awarded prizes and so credit in a similar way to the RHS. Independent journals such as the *Gardeners' Chronicle* – which enjoyed a similar circulation to the *Guardian* and the *Economist* in the period, and is well known to historians of biology for contributions from the likes of Darwin and Hooker – provided forums for the promotion of new varieties and, through their correspondence pages, the airing of disputes as to originality.

Thanks to these and related institutions and publications, seed dealers accrued reputations around particular varieties. To a large extent it was this informally established and maintained reputation coupled with direct sales which protected the largest, most established dealers, at least, against the sale of their varieties as synonyms. Nevertheless, there were also, as noted, some developments over the period of more formal means for protecting the identity of varieties. The oldest piece of legislation was the Adulteration of Seeds Act of 1869. This act arose from contemporary concerns about adulteration and dealt mainly with outlawing various practices used to make old or bad seed saleable. But the Act was largely seen as toothless, since there was no official body to enforce it. Not a great deal more happened until the twentieth century, in particular the period after the Great War. The disruption to the agricultural status quo during the war concentrated minds on the question of how government could best help agriculture, especially as the threat of isolation from trading lines had now become a very real prospect. One of the results of this shift in official attitude was the temporary Testing of Seeds Order of 1917, instigated as a special measure during a part of the war when all agriculture was under government control. The Order stated that all seeds should be certified for identity, germination level and purity in terms of freedom from weeds or disease.

After the war this legislation in turn became the basis for the Seed Adulteration Act of 1920, which demanded the use of certificates for all seeds, produced at point of sale. The government Ministry for Agriculture and Fisheries – a forerunner of the current Department of Environment, Food and Rural Affairs (DEFRA) – oversaw enforcement and provided inspectors to take samples from thousands of businesses that sold seeds, including farms that sold to other farms, and even blacksmiths or grocery stores that sold seed only seasonally and in very small quantities. The Seed Adulteration Act in turn generated a demand for seed testing services. A newly established charity, the National Institute of Agricultural Botany (NIAB), based in Cambridge, became the chief English seed testing station. NIAB was responsible for checking the particulars given in the seed certificates and providing those particulars to vendors. NIAB also published yearly reports on its testing activities in its own journal. It had another role as well: the testing for quality and distribution of new varieties raised by publicly funded research. The seeds for these varieties would be sold by NIAB, who acted as intermediary between research centres and the established seed corn dealers. In this way NIAB exerted some control over the sale of seeds while at the same time utilizing established supply channels and advertising of seed companies such as Carters, Suttons and Gartons. The Institute was also, significantly, responsible for bestowing credit on the new varieties it tested and then reciprocally harvesting that reputation to bolster its own. (see, e.g., Weaver, 1925)

A crucial but easily overlooked additional innovation of relevance here was the growth, alongside publicly funded agricultural research, of an ideal of selfless public service amongst the researchers who depended on that funding. For a glimpse of that ideal in action, consider the following extract from a speech made in 1924, introducing one of the most famous of the publicly funded breeders, Rowland Biffen (about whom more below). The speechmaker was Sir H. Trustram Eve KBE, introducing Biffen at the London Farmers' Club:

> We practical business men, if we have an idea, try to make money out of it; it is human nature, but the scientific man is always working for others without advantage to himself [...] There is no patent, there is no copyright in seeds, and yet

> our scientific friends are spending the whole of their lives in seeing how they can help the farmers of this country. (Biffen, 1924a, p. 2)

Plant Breeding IP and the Rise of Mendelism

Much more needs to be found out about pre-patent IP regimes for plant breeding in Britain in the period that concerns us. But the above outline will serve for present purposes. We turn now to look in a more focused way at how some of this protection activity intersected with the Mendelian debate. Again, we will not try to give a comprehensive analysis. Instead we will examine two particularly instructive moments. The first is in 1901-2, the central figure is the Oxford zoologist W. F. R. Weldon, and the plant variety concerned is a pea variety called *Telephone.*

Weldon and Telephone

1901 was the eve of what is known as the "biometrician-Mendelian controversy," which ran roughly from the beginning of 1902 until Weldon's death in 1906, though its roots extend back into the later nineteenth century. In the opening anti-Mendelian salvo, in the journal *Biometrika* in February 1902, Weldon accused the Mendelians of, amongst other things, exaggerating grossly the ease with which cleanly differentiated varieties could be bred from old ones. To illustrate the point, Weldon referred back to a series of letters published in the *Gardeners' Chronicle* at the end of the 1870s. (Weldon, 1902)
At the heart of the 70s furore was a quarrel about the identity of *Telephone*, a putatively new, putatively wrinkled pea variety. *Telephone* was released by James Carter and Co., who claimed to have produced it by selection from an older variety, *Telegraph*, bred by a Yorkshire breeder named William Culverwell. The trouble arose when Culverwell claimed that *Telephone* was not a new variety at all, but merely the wrinkled peas isolated from *Telegraph*, which gave both round and wrinkled peas. Culverwell had sold to Carter the whole of the *Telegraph* stock – and so the rights over it, in a situation reminiscent of what was happening in America – but he felt that isolating the wrinkled peas from *Telegraph* would ultimately detract from the stock, since the wrinkled peas were reckoned to be more desirable than the round ones. In this way *Telegraph* would eventually become an inferior sample of the same variety. Culverwell felt that if this were to happen, his reputation, as the originator of *Telegraph*, would diminish as the quality of *Telegraph* diminished.

For Culverwell, then, it was above all his reputation as a breeder that was at stake. At Culverwell and the editors' behest, various contributors to the *Chronicle* grew the peas together. Finally the *Chronicle* published its verdict on the case: Culverwell was in the right; *Telephone* was not distinctively different from the stock of *Telegraph*, but was merely an isolated sample of its wrinkled peas. (*Gardeners' Chronicle*, 1879 a, b, c & d) What mattered to Weldon was less this conclusion, however, than the fact that controversies like this one occurred at all. Protracted disagreement over the novelty of putatively new breeds was, Weldon argued, predictable and explicable on the biometrical understanding of heredity, but a surprising mystery on the Mendelian understanding.

As Weldon made plain, the biological issue at stake here was the question of ancestral influence and how quickly or easily it could be stamped out. According to Weldon and others on the biometrical side, ancestral influence was extinguished only very slowly and was very hard to get rid of completely. The principle was summed up in what was known as Galton's Law of Ancestral Heredity. (Galton, 1897 and 1898) There was never any consensus about exactly what was governed by the law or how far it applied strictly; but the essential idea was that hereditary influence could be thought of as dropping away regularly as if in a mathematical series, with parents accounting for ½ of the offsprings' character, grandparents for ¼, great-grandparents for 1/8, and so on. Applied to breeding, the point was that in fixing a new variety, breeders should expect an uphill battle in keeping out unwanted characters – or in other, nineteenth-century words, they should expect reversions to ancestral characters. Even when he wrote, Weldon pointed out, twenty-five generations since the supposedly

originating cross, *Telephone* seeds remained stubbornly variable, in colour but also in shape, occasionally exhibiting both of the characters in the Mendelian contrast pairs and even intermediate characters. As interpreted by Weldon, Mendelism seemed utterly at odds with empirical reality, even on its own home patch of pea varieties. The problem, on his diagnosis, was the Mendelian contention that ancestral influence can go to zero in a single generation: a massive violation of Galton's Law. Although this contention is not familiar as a key Mendelian principle nowadays, it is easy enough to discern its importance if we briefly consider a characteristic Mendelian cross. On textbook Mendelism, when "true-breeding" yellow-seeded pea plants are crossed with "true-breeding" green-seeded pea plants, the hybrid plants in the next or "F_1" generation are all yellow-seeded. When these yellow-seeded F_1 plants are in turn hybridized together, the next, "F_2" generation of pea plants are – again on textbook Mendelism – a mixture of yellow-seeded and green-seeded plants, in the ratio of 3 to 1. The question for Weldon was: are the F_2 green peas (known as the "extracted recessives") identical in hereditary constitution to their green grandparents, despite having had yellow parents? Putting the same question another way, should we expect the F_2 greens to harbour no yellow-making factors whatsoever, and thus to show no hereditary influence at all from their yellow parents? The Mendelians answered "yes", in defiance both of Galton's Law and, as Weldon's marshalled evidence was meant to show, the facts familiar to plant breeders, who knew how hard it was to purify away even quite distant ancestral influence.

In going back to old numbers of the *Gardeners' Chronicle* and a dispute over breeders' intellectual property in pea varieties – a dispute that left traces for Weldon to find thanks to the IP arrangements of the day – Weldon saw himself as documenting the reality of the long reach of ancestral influence, as against Mendelian teachings. The unit characters described as distinct and segregating by Mendel seemed to be anything but in *Telegraph/Telephone*. Furthermore, Weldon argued, disputes of this kind, over the genuineness of putatively new breeds, should be expected, because the fixing of new varieties was far more difficult than Mendelian theory implied.

Biffen and Yeoman II

We now flash forward twenty years to the other side of the debate over Mendelism, and a second moment of IP and Mendelian entanglement, featuring Rowland Biffen and a wheat variety that he was closely associated with, *Yeoman II*. Although, for present purposes, Biffen's moment comes twenty years after Weldon's, they were contemporaries, and indeed were acquainted. Biffen was a star pupil of the most famous Mendelian, and Weldon's main rival, William Bateson, and is often remembered now as the man who first successfully applied Mendelian principles to agriculture, producing new and productive wheat strains including *Little Joss* and *Yeoman* as well as *Yeoman II* (Palladino, 1993; Engledow, 1950). It is not just Biffen's Mendelian allegiances that make him an instructive figure for our story, however. He represented a very different type of breeder from either Culverwell or James Carter and colleagues. Biffen, who taught at the then-new Plant Breeding Institute in Cambridge, was one of the new academic scientists who used public monies to advance agricultural research.

Biffen was well aware of the problem of fixing new varieties or, as the farmers put it, the problem of "rogue" plants within a stock. *Yeoman*, the first famous product of Biffen's labours, had suffered from a rogue problem. When grown by the thousands in a field, a number of out-of-type individuals regularly became obvious, often because they grew taller than the rest. Although his critics suggested that the presence of rogues in fields of *Yeoman* pointed towards a reversion of the strain to ancestral type, Biffen viewed that possibility as a part of hereditary folklore – dismissed a generation before, with Galton's Law and the biometrical opposition to Mendelism generally. For Biffen, the stable character of his new strains was guaranteed by the Mendelian principles by which they had been generated. In defending this view, and defending against the possibility that *Yeoman*'s problem with rogues was a sign that there was a problem with Mendelism, Biffen offered an ingenious explanation. The culprit was the threshing machine, used to separate the corn from the ear, and to separate both from the straw. At the time, threshing machines were often transported from farm to farm, as any individual farmer was unlikely to be able to afford one. In the process of threshing, some corn would become lodged in the machine, which would then travel to the next farm, where, Biffen alleged, the

contaminant corn would become mixed with corn intended for planting the following season (Biffen, 1922; Biffen & Engledow, 1926).

While the *Yeoman* rogues were not particularly troubling to farmers – financially, the problem was insignificant – to Biffen, the plant's identity, as a plant of a certain stable character, was crucial, not least because it was so intimately bound with his own reputation as the great pioneer of Mendelian breeding. Biffen's solution to *Yeoman*'s rogue problem was basically to start again. In November 1922, at the first AGM of the NIAB, while giving a lecture in his role as Chief Scientific Advisor to the Institute, Biffen made his first public mention of the new form of wheat that he had passed to the NIAB for testing and, if deemed successful, distribution. Especially striking is Biffen's dismissal of reversions as a serious problem for the breeder. The report virtually opens with the claim that, "There is no difficulty in fixing these types; so-called cases of reversion are traceable to mixture of stocks in travelling threshing machines" (Biffen, 1922. p. 45). The main reason given for the release *Yeoman II* was, accordingly, to purify contaminated seed stocks. A second reason given was that *Yeoman II* was supposedly a superior variety of wheat. Biffen was quoted in 1923 in *Nature* as saying, "the sooner Yeoman is off the market the better." (*Nature*, 1923, p. 734)

In the *Journal of the Ministry of Agriculture* in September 1924, Biffen again stated that the new strain was a remedy for the impurities of old stocks. At the end of the article, which announced the release of the new variety, Biffen laid claim to the most obvious form of protection placed upon the release of *Yeoman II*, the seal to be placed on the sacks in which it would be sold: "The attention of farmers is particularly drawn to the fact that genuine seed of Yeoman II can only be obtained in sacks closed with the seal of the National Institute of Agricultural Botany" (Biffen, 1924b, p. 512). These seals were the means of protecting the release of *Yeoman II*. Tenders were only to be made to the NIAB, the price was fixed, and the seed certified as genuine and superior by the NIAB seal on the sacks it was sold in.

Toward a New History of the Mendelian System

By 1924, variability no longer – as it had for Weldon – pointed up an anti-Mendelian conceptual lesson. It merely illustrated a practical problem, to be addressed by releasing a pure stock of seed through well-managed means of distribution. The sacks and seals used to protect the plant varieties bred into existence by Mendelian principles thus ended up protecting those principles as well; all apparent reversion or character instability could henceforth be presumptively blamed on "external" contamination. That alibi, as much as the sacks and seals, is invisible in the current historiography of the rise of Mendelism. A more comprehensive analysis of the Mendelism/IP interconnections than the one attempted here would have much more to say about them, and also about the other components of what can perspicuously be described as a Mendelian system. A partial list would include the NIAB, the Plant Breeding Institute, the Ministry of Agriculture (which funded both), the other, less successful, Mendelian varieties, and the textbooks in which the success of Mendelian plant breeding was exhibited as a sign of Mendelism's truth. Helping us not take for granted the emergence of this system, or the inevitability of the genetics that was its legacy (see Radick, 2005), is a task for the future.

References

Biffen, R. H. 1922. "Meetings of the Fellows of the Institute: First Annual General Meeting." *Journal of the National Institute of Agricultural Botany 1 : 45-50.*

Biffen, R. H. 1924a. "Modern Wheats." *Journal of the Farmers' Club Part 1 : 2-18.*

Biffen, R. H. 1924b. "The New Wheat Yeoman II." *Journal of the Ministry of Agriculture 31: 509-512.*

Biffen, R. H. & Engledow, F. L. 1926. *Wheat-Breeding Investigations at The Plant Breeding Institute, Cambridge: Research Monograph No. 4,* London : Ministry of Agriculture and Fisheries.

Engledow, F. L. 1950. "Rowland Harry Biffen. 1874-1949", *Obituary Notices of Fellows of the Royal Society 7 : 9-25.*

Galton, F. 1897. "The Average Contribution of Each of Several Ancestors to the Total Heritage of the Offspring." *Proceedings of the Royal Society of London 61, 401-413.*

Galton, F. 1898. "A Diagram of Heredity." *Nature 57*: 293.

The Gardeners' Chronicle. 1879a. "Culverwell's Telegraph and Carter's Telephone Peas." *The Gardeners' Chronicle 1st February : 148.*

The Gardeners' Chronicle. 1879b. "Culverwell's Telegraph and Carter's Telephone Peas." *The Gardeners' Chronicle 1st February : 210.*

The Gardeners' Chronicle. 1879c. "Culverwell's Telegraph and Carter's Telephone Peas." *The Gardeners' Chronicle 8th February : 180.*

The Gardeners' Chronicle. 1879d. "Telegraph and Telephone Peas." *The Gardeners' Chronicle 2nd August : 146.*

Kevles, Daniel J. 2007 "Patents, Protections, and Privileges: The Establishment of Intellectual Property in Animals and Plants." *Isis 98 : 323–331.*

Nature, 1923. "Current Topics and Events." *Nature 112 : 734-8.*

Palladino, P. 1993. "Between Craft and Science: Plant breeding, Mendelian Genetics and British Universities, 1900-1920." *Technology and Culture 34 : 300-323.*

Palladino, P. 2002. *Plants, Patients and the Historian: (Re)Membering in the Age of Genetic Engineering,* Manchester : Manchester University Press.

Radick, Gregory. 2005. "Other Histories, Other Biologies" in Anthony O' Hear (ed.), *Philosophy, Biology and Life.* Cambridge : Cambridge University Press. 21–47.

Weaver, Sir Lawrence. 1925. "The Institute 1917-24. – A Retrospect." *Journal of the National Institute of Agricultural Botany, 1(3) : 51-57 (paper read at the 3rd AGM 14th November 1924).*

Weldon, W. F. R. 1902. "Mendel's Laws of Alternative Inheritance in Peas." *Biometrika 1 : 228-254*