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Biogr. Mems Fell. R. Soc. published online August 30, 2017 originally published online August 30, 2017

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JOHN PHILIP COOPER CBE
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Elected FRS 1977

BY KENNETH EDWARDS*

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John Cooper’s innovative research into the genetics of plant growth and development was established with the aim of identifying characters which would guide plant breeders in their selection programmes. Working with certain forage grasses (mainly ryegrass but also cocksfoot and fescue), he analysed growth and development into components, including flowering time, leaf development, photosynthetic efficiency, canopy structure in the crop and nutritional quality. He and his colleagues were able to show, by a combination of selection experiments and comparisons of variance between and within families, that considerable genetic variation existed within all varieties of these outbreeding crops. All the characters were polygenic, with no evidence of individual genes manifesting distinct Mendelian ratios. Cooper obtained information of great value for the plant breeders with whom he worked closely. His research stimulated others to build on his ideas when new molecular techniques became available.

After two decades of creative research at the Welsh Plant Breeding Station, John Cooper became its Director in 1975. This coincided with a turbulent period in government-sponsored agricultural research that involved reductions in funding. Cooper disagreed with the underlying policy changes, but he worked hard to minimize the number of redundancies and the damage to the scientific work of the station. Overall, John Cooper had a distinguished scientific career. His personal achievements from his own research activities and that of his colleagues were unique and innovative. He led by example, by stimulation and by inspiration, and developed a wide international influence for his ideas.

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Early years

John Philip Cooper was born on 16 December 1923 in Buxton, Derbyshire. His parents, Frank and Nora Cooper, both came from farming families in Cheshire, but his father was a successful corn merchant and miller. In his early boyhood, John was known as Philip to his immediate family. His health caused sufficient concern for the family to move when he was aged nine from Buxton, with its cold wet winters, to High Lane in Cheshire, which had a milder climate (Figure 1). High Lane is on the western edge of the Pennines with views to the west across the Cheshire Plain and, in good weather, to the mountains of Wales. The village was a base for John’s exploration, on foot and by bike, both to what is now the Peak District in the east and to the Cheshire Plain in the west, where several members of his wider family farmed. His lifelong love of the countryside and of nature developed from these excursions.

After a couple of years in local primary schools in High Lane, John was awarded a Cheshire county scholarship to Manchester Grammar School, but his parents decided that the daily journey of 15 miles each way would be too great, so instead he went to Stockport Grammar School, which was only 4 miles away and on a direct bus route. This was run on the lines of an English public school (the headteacher later became Headmaster of Dulwich College), which John and many of the scholarship intake did not appreciate. But he did acknowledge the excellence of the teaching and the high academic standards of the school, although he
regretted the lack of emphasis on biological and environmental topics, which would have reflected his interests in natural history and the countryside. In the sixth form this limitation became more pronounced, with the science stream (the other stream being literary) consisting of mathematics, physics and some chemistry. Nevertheless, John worked hard, achieved form prizes in both years and obtained a Cheshire County University Scholarship. His school hoped that he would take a mathematics degree, perhaps at Cambridge, but he had clear ideas of his own. With his deep interest in natural history and his knowledge from the farming activities of his wider family, he opted to read for an agricultural degree at Reading, specializing in agricultural botany – and this he started in 1941.

By September of that year the war had already been in progress for two years, and at 18 John had to register for call-up for military service. As a sixth-former during the early war years, he had kept an allotment and acted as a fire watcher and messenger boy for the local land forces. At Reading, because of the nature of his university course in agriculture, he was allowed to defer being called up, subject to regular review and to service in the University Senior Training Corps. The latter involved a half-day each week on basic training, with ‘manoeuvres’ at weekends and in camps during vacations. Otherwise, John was free to pursue his academic course, which he did with enthusiasm.

**University Education**

John entered the University of Reading on a four-year course in the Faculty of Agriculture (Figure 2). Those students who did not have direct agricultural experience – such as having been brought up on a farm – were required to undertake a foundation year, which included botany, zoology and geology, none of which had been available to John at Stockport Grammar School. The final year (1944–1945) had four terms, presumably to make up for lost time spent on Senior Training Corps activities. John specialized in agricultural botany, made good use of the time and obtained a first-class degree. He particularly mentioned Tom Harris (FRS 1948), the Professor of Botany and an expert in palaeobotany, and W. B. Brierley, a plant pathologist, who was professor and head of the Department of Agricultural Botany, as inspiring teachers. These observations show that he benefited from the wide subject range available in the early years, before turning to crop botany and plant genetics and breeding. There is little indication of John’s involvement in student activities, beyond his academic studies – perhaps being a student with a world war happening at the time encouraged a very serious approach to coursework, which in any case he clearly enjoyed. However, he did not find Reading and the area very enjoyable, referring to it as a ‘rather flat and featureless place’.

After Reading, John’s next step was to take up a Colonial Office scholarship in Cambridge, but, before starting this in September 1945, he spent the intervening months as a summer assistant at the Welsh Plant Breeding Station (WPBS) at Aberystwyth. He worked in both the clover- and grass-breeding departments and enjoyed the practical experience he gained. There was another very significant encounter at Aberystwyth; he found himself working alongside another summer assistant, Christine Palmer, who had recently graduated from the University College of Wales, Aberystwyth. Six years later they married.

After that summer in Aberystwyth, John moved to Cambridge to take up the Colonial Office scholarship in plant breeding and genetics, with the expectation that after one year in Cambridge the students would transfer to the Imperial College of Tropical Agriculture
in Trinidad for a further year of training. The Cambridge course consisted of lectures from academics in the university departments of agriculture, genetics and botany, as well as from staff at the Plant Breeding Institute in Cambridge. Students also undertook a research project; in John’s case, this involved study of chromosomal behaviour in a potato-breeding programme to introduce blight resistance from wild relatives.

During his year in Cambridge, health problems (probably glandular fever) arose, leading to the conclusion that John would not be fit for work in the tropics. The Colonial Office scholarship was terminated after one year, so in the summer of 1946 he left Cambridge with a diploma in agricultural science (plant breeding and genetics), but without a job.

**FIRST JOB IN ABERYSTWYTH**

Watkin Williams, the head of clover breeding at WPBS and in whose department John had spent time as a summer assistant in 1945, wrote to tell him that a post of scientific assistant in grass breeding was about to be advertised. John applied and was appointed, thus starting in a humble position at an institute of which he would eventually become director. He was formally attached to the grass-breeding department, but seems to have created for himself a wide-ranging portfolio of jobs, including some personal research. In this, he looked at the flowering responses of a range of *Lolium* (ryegrass) species, including both outbreeding and self-fertilizing types. He related the flowering responses to the ecological conditions of the area from which the plants originated and made preliminary estimates of the extent of genetic
as opposed to environmental variation. Some of these findings were incorporated subsequently in his PhD thesis. The experience set the direction for his future research activities, initially in Reading and then back at WPBS.

John greatly enjoyed WPBS, Aberystwyth and the surrounding area, and he had an active social life, making many friends. One very important feature of his social life was meeting Christine Palmer again, when she returned to Aberystwyth to visit friends from her student days.

**Academic life in Reading University**

After four happy years as a scientific assistant at WPBS, John was appointed to a lectureship in the Department of Agricultural Botany in Reading. The particular reason he was attracted to return to Reading was his respect for W. B. Brierley, the head of department. He enjoyed teaching plant breeding and genetics, both to students reading a range of courses in agriculture and to the specialist final-year group in agricultural botany.

Research on flowering responses of a number of species of the genus *Lolium* continued, together with new and parallel studies on varieties of wheat. In 1953 John gathered his findings into a PhD thesis, which he successfully submitted to Reading. The external examiner was Professor P. T. Thomas from the Agricultural Botany department at Aberystwyth, later to become Director of WPBS.

Despite the success of his PhD award, John found the atmosphere in the department at Reading less stimulating for his research than he had sensed at Aberystwyth. It may be that his mind was often in Wales, for Christine was there, though not in Aberystwyth. She now lived on the Gower Peninsula, where, together with her father, she had developed a small but very successful dairy farm. John’s frequent visits to the Gower and meetings at other places deepened their relationship; they married in September 1951. They bought a house in Reading and their son, David, was born in 1952. But Wales beckoned.

**Productive years in Aberystwyth**

In September 1954 John once again joined the staff of the WPBS, which was funded by the Agriculture Research Council (ARC). He was appointed as a plant geneticist in the grass-breeding department. The WPBS had been founded in 1919 at the University College of Wales, Aberystwyth. Its first director was the visionary George (later Sir George) Stapleton, whose particular aim was to improve the pastures of the hills of Wales. Plants were collected from the best pastures, then subjected to selection on the basis of vigour, persistence and yield in grazing or cutting trials. The selected plants were put through a number of generations of multiplication to produce sufficient seed for the market. These final stages had to ensure that the seeds sold to farmers were of high quality and free from impurities. Using these methods, the station had great success with a number of new and vastly improved varieties of forage grasses and clovers.

By the 1950s, however, most of the ‘low hanging fruit’ accessible to such methods had been picked, and the station was looking for new approaches to plant breeding for grasses in particular. This became John’s remit. It was a task well suited to his background, for in his school days he had been fascinated by the natural world and its variation and adaptations to
particular environments. Furthermore, the family background in farming meant that he felt a satisfaction in being a research scientist with the aim of improving agricultural practice. An additional benefit was that he had returned to a place he had learned to love.

So what was the aim of his scientific programme? John believed that a fuller understanding of the physiology and developmental processes in the growing grass plant would help the breeders to define characteristics that they should aim for. Forage grasses convert light energy and nutrients into leaves which grazing animals can eat. Because of seasonal differences, grasses can also be harvested as hay or silage to provide animal food for the winter. For the latter purpose, the grass crop will be harvested after the plants have switched from vegetative to reproductive growth. This switch was the first process which John studied in detail. His starting material consisted of existing varieties which had been grown in different environments or for different purposes (grazing or hay production). He concentrated on perennial ryegrass (*Lolium perenne*), but also investigated other *Lolium* species and other genera, such as *Dactylis* and *Festuca*. The species of grasses that are most important in British agriculture are outbreeding and are largely self-sterile, so any population is likely to be genetically heterogeneous. This is indeed what was found for flowering time (as determined by date of ear emergence), where, in two different *L. perenne* varieties (Irish (early flowering) and Kent (later flowering)), selection for either earliness or lateness produced in only three generations lines with mean values outside the range of the original populations (1)* (Figure 3).

Given the outbreeding nature of perennial ryegrass it was not surprising that particular strains were heterogeneous for flowering time, although the high level of variation was unexpected. But for the analysis of the genetic differences there is a downside of the cross-pollinating system. Flowering time, as with all the other physiological and developmental characters that Cooper and his colleagues studied, shows continuous variation and the underlying genetic variation will probably involve many genes (polygenic). Although simple selection experiments show that genetic differences are present, no individual gene has a sufficiently large effect as to expose distinct segregation ratios. Analysis of such variation can be much more informative if true inbred lines exist: these will be homozygous for all genes. Inbred lines cannot be produced in *Lolium perenne*; self-fertilization is difficult to achieve and rapidly produces weak and infertile plants, while sib mating has similar consequences, albeit less rapidly. However, analysis of variance between and within families produced by controlled crosses can provide estimates of additive genetic variation (the average effect of allelic substitution over all the genes which are segregating). In addition, some measure of dominance effects can be obtained.

Selection experiments demonstrated that considerable levels of additive genetic variation existed within the commercial strains that were John’s base populations, with responses continuing for six generations. If only two individuals were used as parents in each generation, inbreeding depression occurred, but this was not observed in lines based on four parents per generation. Selection for flowering time did not produce consistent correlated changes in other reproductive characters, such as length of ear or number of spikelets per ear.

These selection experiments were conducted in parallel on two strains, one of which had been grown mainly for hay and was early flowering, while the other strain was a pasture type. In both types, large amounts of genetic variation for flowering time were found. For strains

* Numbers in this form refer to the bibliography at the end of the text.
grown in pastures, it is agriculturally desirable that they do not flower because that diverts energy from leaf production. Cooper demonstrated that the switch to flowering in ryegrass is dependent on day-length exceeding a critical value, and that this threshold is higher in pasture strains than in hay types. Selection for a day-length requirement in excess of the maximum occurring at a particular latitude would mean that the plants remained vegetative and suitable for grazing; but seed production would have to be achieved further north.

John demonstrated the existence of additive genetic variation for flowering time in several species of *Lolium* and of other genera (*Dactylis* and *Festuca*), and noted the potential that changes in the time of flowering could be included in a breeding programme. He and his colleagues next turned their attention to aspects of leaf development, which is important in

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**Figure 3.** Graph showing the date of ear emergence in Irish and Kent varieties of *Lolium perenne*: (a) the range of the original populations (vertical lines); (b) the overall range of all the selected lines (dashed lines); (c) the mean values of the selected lines for either earliness or lateness (solid lines EE and LL); and (d) the mean values of sub-lines where the direction of selection was reversed after one generation (solid lines LE and EL). From (1), reprinted by permission from Macmillan Publishers Ltd.
grass plants because leaves are where photosynthesis occurs and because leaves are also the main agricultural product of these forage plants. Similar experimental programmes involving studies of variation between and within families and selection for high and low expression were performed for leaf size and rate of leaf production. Here again, considerable additive genetic variation was identified in both characters, with selection producing responses outside the extremes of the original populations. However, this time there were significant correlated responses: selection for large leaves was accompanied by a reduction in the rate of leaf production, and vice versa. Thus selection was shifting resource allocation within the plant without appreciably affecting the total leaf area (3). However, leaf area is not the only character affecting overall yield: the rate at which carbon can be assimilated from the atmosphere by photosynthesis is also a potentially important variable.

John and his colleagues attempted to distinguish the relative contributions of variation in leaf area and rate of photosynthesis by analysing and comparing growth rates in different genotypes from several species in distinct environments. In general, in European material there was more genetic variation in net assimilation rate (NAR, rate of weight increase per unit leaf area) than in leaf area ratio (LAR, leaf area per unit weight of plant). But genotypes from Mediterranean regions varied more in LAR. In all these experiments, marked interactions occurred with environmental variables, suggesting that performance of any selected material on these criteria would be unpredictable over the range of agricultural conditions. Further experiments took this approach deeper into fundamental physiological processes by measuring 'apparent photosynthesis' (the rate of CO₂ uptake, being the balance between photosynthesis and respiration). Again genetic differences were detected, both between and within forage grass species, but here too there were marked interactions with environmental variables (5).

John was well aware that in some species of the Gramineae (Poaceae), including maize, a different biochemical pathway was involved in fixing atmospheric carbon utilizing a 4-carbon molecule (C₄ species) rather than a 3-carbon (C₃ species) form. These C₄ species are more efficient carbon fixers than the C₃ counterparts and include many tropical grasses as well as maize. John compared two C₄ species (maize and a tropical grass, *Cenchrus*) with two C₃ genera (*Lolium* and *Avena*). The C₄ plants grew faster at temperatures in the 30–35°C range but no faster when the temperatures were in the low 20s°C (4). Study of the differential responses of grasses to environmental variation in temperature and photoperiod was a thread running through much of his work. These factors are geographically determined and he realized that local populations become adapted to them. Collecting plants from such localities would provide genetically diverse material for genetic experiments and breeding programmes (2).

While such experiments on individual plants provided important understanding of growth processes in a range of mostly European forage grasses from temperate climates, crops actually grow in swards where a canopy of leaves intercepts light, some leaves casting shade on others. Studies of variation in the properties of the leaf canopies comparing several species of forage grasses in different light energy regimes also demonstrated genetic variation, but here too genotype–environment interactions occurred. Variation in canopy structure influences total growth but is also relevant to utilization of the grass produced. Grasses with prostrate leaves would rapidly achieve total ground cover and therefore maximum light interception compared to those with more erect leaves, but produce lower total leaf matter. However, the former would be better able to survive grazing by sheep and cattle.
John Philip Cooper

John Cooper made major contributions in demonstrating the role that genetic variation plays within populations of *Lolium perenne* and other forage grasses for developmental features such as flowering time and leaf characters, but he also realized the significance of understanding fundamental aspects of metabolism. To this end he worked with colleagues to investigate the contributions to genetic variation of photosynthesis, respiration and nitrogen metabolism. He was much involved in the setting up of the department of biochemistry within WPBS, where these ideas could be pursued in detail.

Working with other departments at WPBS, John also investigated variation in nutrient quality of grasses, clearly a characteristic of great importance. While he liaised closely with other members of staff, most of the highly innovative and creative work in grass physiology and development with which he was associated was in collaboration with a succession of PhD students and postdoctoral visitors. He was an excellent supervisor and leader, inspiring and enthusiastic, while always being willing to listen and discuss. His enthusiasm was infectious, creating a very positive atmosphere in his Department of Developmental Genetics. His arrival each morning would often be announced with a cheerful ‘Hey, Hey’ and the sound of his half-run, half-skip along the corridor in his haste to do things. It seems that this style of movement also happened at home, for one day he appeared in the lab with an arm in a sling. He explained that in a hurry to get from one room to another he had failed to make sure that the intervening door was fully open. The consequence was that he collided with the leading edge of the door, cracking a rib. That he cheerfully told this story against himself was characteristic of him.

John had no sense of self-importance, as I realized soon after I arrived as a research student at WPBS. The station was at Plas Gogerddan, about three miles from Aberystwyth. One day I missed the last bus back to Aberystwyth (which went about 5.30) and was facing the prospect of a long walk when I realized that JP (as he was always known) was still there. He readily offered me a lift in his Ford Prefect. However, I became acutely embarrassed when I rested the point of my umbrella on the floor of the car – only to find to my horror that it went through. I profusely apologized, fearful that what I hoped would be the start of a research career might be cut abruptly short. But John apologized that he should have fixed the hole! In fact, John was dedicated to science and unconcerned about material things such as cars. On another occasion he tried to drive through a ford on the road to WPBS which, except after heavy rain, was usually dry. This trip followed heavy rain when the ford had been flooded, and his car became stranded. He was towed out by a farm tractor and able to get the car mobile again. Later that day he took his family in the car and it was noticed on arrival when the doors were opened that all, except John, were keeping their feet high to avoid the water that remained in the passenger compartment. He commented that driving was ‘not too bad, except when I braked and a tidal wave swept forward and soaked my feet’.

John’s work was an integral part of the overall aims of the WPBS – to produce new varieties of crop plants suitable for agriculture in Wales and other highland areas of the UK – and he worked closely with colleagues in other departments, especially in Grass Breeding. In 1971 he and Les Breese (then head of Grass Breeding) published a paper which described their joint approach to achieving these aims (6). In addition to setting aims for plant selection in breeding programmes using criteria arising from studies in physiology and development, his work also showed that desirable characteristics occurred in plants from other environments, such as the Mediterranean region. In some cases these types could be crossed readily with local lines, for example within *Lolium perenne*, but in other cases the hybrids were chromosomally unstable and polyploidy might have to be induced to create stability. While devoting his main activities
towards fundamental research, John remained well aware that the aim of his investigations was to inform and underpin the plant breeding objectives of WPBS. He ensured that he communicated the outcome of his experiments not only to the other staff of the institute but also to a wider audience of agriculturists (Figure 4).

From 1954, when John returned to Aberystwyth as a WPBS staff member, until the early 1970s, he had a couple of decades of remarkably productive research. This he achieved despite two innate problems of working with outbreeding species. The first of these is that any new variety produced is likely to remain genetically variable and therefore suffer from natural selection during seed multiplication stages, consequently not necessarily breeding true. The other problem is that for outbreeders there are limits to the level of genetic analysis that can be achieved, compared with inbreeders such as maize. More recent techniques, based on molecular genetics, and identifying ‘quantitative trait loci’ (QTL), have allowed more refined study of particular regions of DNA associated with continuously variable characters. Had they been available in John Cooper’s time I am sure that he would have adopted them with great enthusiasm, but by then he had moved into a senior management role as Director of the WPBS.

John’s research on fundamental physiological processes and the genetic variation that he and his colleagues demonstrated in such characters indicated possible approaches to plant breeding of these forage grasses. He was well aware that it would not necessarily be simple to effect the transition to application. In a paper published in 1981 (7) he surveyed the overall findings of his work and noted that effective use of such studies in breeding programmes must depend ‘on the identification of those components that are most important in determining yield or quality, and the development of rapid and reliable screening procedures that correlate well with the performance of the crop in the field’. It was a number of years before he could personally begin to follow up the idea of working on ‘rapid and reliable screening procedures’. That had to wait while he undertook major administrative and managerial responsibilities.
John Philip Cooper

Figure 5. John explaining an experiment in a greenhouse at the Welsh Plant Breeding Station.

**DIRECTOR OF WPBS**

Professor P. T. Thomas retired as director of the WPBS in 1975, having been in that post since 1958. During that period he had achieved considerable expansion of the institute, including the installation of a suite of growth chambers which had allowed John Cooper and his colleagues to conduct experiments using a wide range of environmental variables in temperature, photoperiods and light intensities. He was happiest in the greenhouse or growth chamber, talking enthusiastically about his experiments (Figure 5).

John, as the outstanding scientist on the staff, was an obvious candidate for the directorship, and his colleagues within the institute pressed him to apply. He was very reluctant to do so and would have preferred to continue as a research scientist. But eventually he accepted. Simultaneously with his appointment as director, he became a professor in the Department of Agricultural Botany in the University College of Wales, Aberystwyth.

John’s reluctance to take on the task was based on his natural desire to spend time on his personal research, but also because he did not think he was suited to administration. It is illuminating that in the personal notes that he subsequently wrote (he seemed to have had in mind writing a memoir), he is brief on his spell as director, as if he did not want to dwell on this period. He was, perhaps, too nice for the rough and tumble of managing a large organization. Those qualities of open approachability and friendliness that made him an excellent leader of a small scientific team needed supplementing with a harder edge in dealing with the range of conflicting and demanding interests within and outside the institution. He notes that it was
once said of him, ‘The trouble with John Cooper, he has no guile’. John’s response to this was ‘a comment I have treasured, but it did not make me a very effective institute director’! Guile is defined in the *Oxford English Dictionary* as ‘a deceit, stratagem, trick’. While these may seem unpleasant characteristics, anyone who has run a large organization will know that in many negotiations – both within and outside the organization – it is wise to avoid putting one’s cards on the table at the beginning. If that is guile, then John’s acknowledged lack of it made it difficult for him to be an effective director. Others have said about him in that capacity that he lacked ruthlessness and that he was ‘too nice a person to admonish when necessary’.

The single most difficult internal issue that he faced was the opposition within the station to the dismissal of a member of staff. The unions organized a mass demonstration outside his office in support of the dismissed individual. John would have hated that – but the situation became tragic when a couple of days later James Ellis, the most senior administrator who had ordered the dismissal, suddenly died. Anyone in his position would have been upset by these events, but for someone as sensitive as John it must have been terrible. I think that he would not have enjoyed being director even in times when there were few external pressures on WPBS, other than the professional expectation to produce high-quality research aimed at creating improved varieties of crop plants. However, John did not have that luxury because, during his directorship, government policy changes produced turmoil in the publicly funded research system.

For most of the period of John’s very productive research activity, the allocation of government funding for basic research had operated under the Haldane Principle. The Haldane Report of 1918 led to the setting up of the research councils, of which the Agricultural Research Council was one. Haldane’s Principle was that ‘decisions about what to spend research funds on should be made by researchers rather than politicians’. This system prevailed, despite challenges – such as that it encouraged an undesirable separation of basic and applied research – until the 1972 Rothschild Report (produced by another peer) into government support of research and development. Rothschild recommended that funding should be allocated according to a ‘customer/contractor’ arrangement. The Report declared that ‘The concepts of scientific independence used in the Haldane Report are not relevant to contemporary discussion of government research’. In the case of agriculture, the customer would be the Ministry of Agriculture (MAFF), while ARC becomes the contractor.

The aim of this change was to focus publicly funded research towards practical outcomes, as determined by politicians. The result was that some funding was transferred from ARC to MAFF. Initially the effect was not large, with MAFF agreeing to maintain much of the ongoing research within ARC programmes, but in the following years there were considerable changes in the arrangements for funding agricultural research, with the ARC becoming the Agricultural and Food Research Council in 1981 and then the Biotechnology and Biological Sciences Research Council in 1993. That last change occurred after John Cooper had retired, but the substantial reorganization of research council activities leading up to it did affect his final years as director. One consequence of this reorganization was the closure and merger of some ARC-funded institutes, with a reduction in overall funding and the necessity for many redundancies. The redundancy programme affected WPBS and John had to implement it. He worked hard to minimize the effect on the staff but still had to undertake the unpleasant task of making individuals redundant. He was very unhappy to have to do this.

In his notes he reports that he contemplated taking early retirement in 1977; this was the year in which serious staff protests over a dismissal occurred and James Ellis suddenly died.
He stayed in post until he reached 60, and retired on his 60th birthday (16 December 1983), leaving WPBS and Aberystwyth for a new home in Gloucestershire, to which Christine had already moved. He noted that he did not return for at least two years. It is very sad that, after nearly four decades since his first involvement with WPBS as a summer assistant, followed by many years of enthusiastic commitment and major contributions to its reputation, his time with the Station ended with some unhappiness.

PERSONAL REPUTATION

John Cooper’s research was a major factor in establishing the WPBS as an important centre of plant research, especially in the context of plant breeding. In 1976 this excellence was recognized by the granting of the Queen’s Award for Technological Achievement, specifically for the development and successful commercialization of tetraploid hybrid ryegrass (Figure 6). The new variety had been developed in the Herbage Plant Breeding Department, headed by Dr Les Breese, but it reflects ideas floated by John. John’s personal reputation was by now well established and his outstanding research was recognized by election to the Fellowship of the Royal Society in 1977. This distinction was followed by his appointment in 1983 as Commander of the Order of the British Empire; an honour which, with typical modesty, he regarded as ‘not really greatly deserved’. He had been awarded a DSc by the University of Reading in 1964.
John Cooper’s research was widely regarded internationally. Many visitors came to Aberystwyth to work with him or to talk to him about his research. And John made many trips to other countries. In 1962 he was awarded a Royal Society/Nuffield Foundation Commonwealth Scholarship in order to attend a conference on the occasion of the formal opening of the new phytotron in Canberra. He took advantage of this event to visit India, Malaysia, New Zealand, Fiji, the USA and Canada. He returned with clear ideas for the next steps in his research programme. He also returned to new controlled environment facilities in a new building, the Sir George Stapleton Building, which would house his Department of Plant Genetics. The topics which he intended to study, following the earlier demonstrations of large amounts of genetic variation for flowering time and leaf development in ryegrass and other forage grasses, included photosynthetic activity in the whole plant and in individual leaves, canopy structure and light penetration.

Subsequently, his international activities included visits to give lectures and speak at conferences and act as a consultant in Uruguay, Czechoslovakia, Finland, Russia, Malaysia, the USA and several African countries. He was involved in the International Biological Programme, contributing to both its research programmes and publications. He also became a board member of the International Board for Plant Genetic Resources, which required frequent visits to Rome.

**Retirement**

In December 1983 John and Christine Cooper moved from their house in Aberystwyth, where they had lived for nearly 30 years and in which they had brought up four children, to Minchinhampton in Gloucestershire. In thinking about where to live in retirement they had contemplated the Gower peninsula in South Wales, where Christine had spent happy years running a dairy farm before she married John, but eventually decided on the Cotswolds. John had many continuing professional activities and Gloucestershire was a more convenient base for travelling both within the UK and overseas.

John became a member of the Council of the Royal Society and some of its sub-committees, which required frequent visits to London, while he also had roles with other research institutes, supervised thesis preparations for research students and was an examiner for others. The University of Reading appointed him visiting professor in the agricultural botany department, where he collaborated in research programmes on barley. This work resulted in four joint papers with members of that department. His concern that breeders should assess physiological responses across populations from a wide geographical range continued in these studies. The effects on flowering induction of variation in temperature (vernalization) and photoperiod showed a range of responses over a number of accessions of barley (*Hordeum vulgare*) (8). The effects were detected in early stages of growth, with the aim of developing rapid assessments of new populations. In his last published paper, in 1991, he extended these aims by turning again to one of his earliest favourite species, *Lolium temulentum*. He and his colleagues reported investigations of vernalization treatments on in-vitro cultures of embryos, shoot apices and callus tissue. It is intriguing to note that in this paper his affiliation is again the WPBS (9).

During the early years of his retirement John continued to travel extensively, despite a chronic back problem. This was diagnosed as osteoporosis, which he had thought occurred
only in post-menopausal women. Treatment included an exercise class of 12, in which he was the only man. His back problems were painful and inconvenient, but worse was to happen when, in 1988, while walking in the countryside, he suffered chest pains, a rapid pulse rate and feelings of nausea. An emergency dash to hospital led to a diagnosis of supraventricular tachycardia (SVT). The treatment was successful but thereafter he was constantly taking medication and undertook only limited travel. Air travel was forbidden.

Spending more time in Minchinhampton had many compensations and John was busy in the local community, in particular enjoying the activities of the archaeological society. This was a subject which had always intrigued him because it linked the area in which he lived to its earlier inhabitants. John was not a conventionally religious person; his boyhood experience of strict Methodism had put him off formal Christianity, and his scientific thinking did nothing to overcome that rejection. However, he found satisfaction and a sense of fulfilment in attending meetings of the local Quakers, although he never became a member. Gardening had always been one of his enthusiasms and he had a greenhouse at home. For a while he grew barley in it because of the research he was doing with the Reading group, but later he filled the greenhouse with pinks (*Dianthus caryophyllus*), on which he did some genetic experiments, while also providing a supply of cut flowers for the house and for local charity shops.

The thrust of the scientific work which John Cooper did with such dedication and excellence was rooted in his fascination with the natural world he had encountered in his childhood in Cheshire. In retirement in Gloucestershire he found satisfaction in the parallels between his current environment and remembrances of his early years. He noted that both Buxton and Minchinhampton were on limestone ridges, that there were quarries near to both and that from both there were views across plains (the Cheshire Plain in the north and the Severn Valley in the south) towards Welsh mountains. These feelings reminded him of the *Four Quartets* of T.S. Eliot and one particular passage in ‘Little Gidding’:

> We shall not cease from exploration
> And the end of all our exploring
> Will be to arrive where we started
> And know the place for the first time.

John Cooper was a wise man, a very fine scientist, a dedicated husband, father, grandfather and great-grandfather, and a generous mentor to many.

**ACKNOWLEDGEMENTS**

I am greatly indebted to John Cooper’s son, Dr David Cooper, and, through him, to other members of the family for the provision of much information and of photographs, and for very helpful comments on an early draft. Dr Malcolm Calder and Professor Chris Pollock provided much valuable input into the account of John Cooper’s scientific output and were also helpful in commenting on the early draft. Mrs Auriel Evans was extremely helpful in supplying details of John Cooper’s time as Director of the Welsh Plant Breeding Station. The frontispiece photograph was taken in 1978 by Godfrey Argent and is reproduced with permission.
Ken Edwards’ family background was similar to that of John Cooper. His parents’ farm was in north Shropshire, which is in fact an extension of the Cheshire Plain where John spent his childhood more than a decade earlier. Like John he roamed the countryside observing wildlife and the routines of farming. He too did a degree in agricultural botany in Reading and, like John, obtained first-class honours. He then became one of John’s first research students at the WPBS at Aberystwyth, working on the genetics of leaf development in ryegrass. This was followed by a year as a postdoc studying population genetics at the University of California at Davis, after which he returned to WPBS as a staff member in John’s new Department of Developmental Genetics. In 1966 he moved to the Department of Genetics in the University of Cambridge, continuing to work on the genetics of polygenic characters in plants. In 1984 he moved into full-time university administration and management, first in Cambridge but from 1987 as the Vice-Chancellor of the University of Leicester. From 1994 to 1999 he was Chairman of the Governing Board of the Institute of Grassland and Environmental Research (IGER), the successor to WPBS.

### Bibliography

The following publications are those referred to directly in the text. A full bibliography is available as electronic supplementary material at http://dx.doi.org/10.1098/rsbm.2017.0020 or via https://doi.org/10.6084/m9.figshare.c.3854770.