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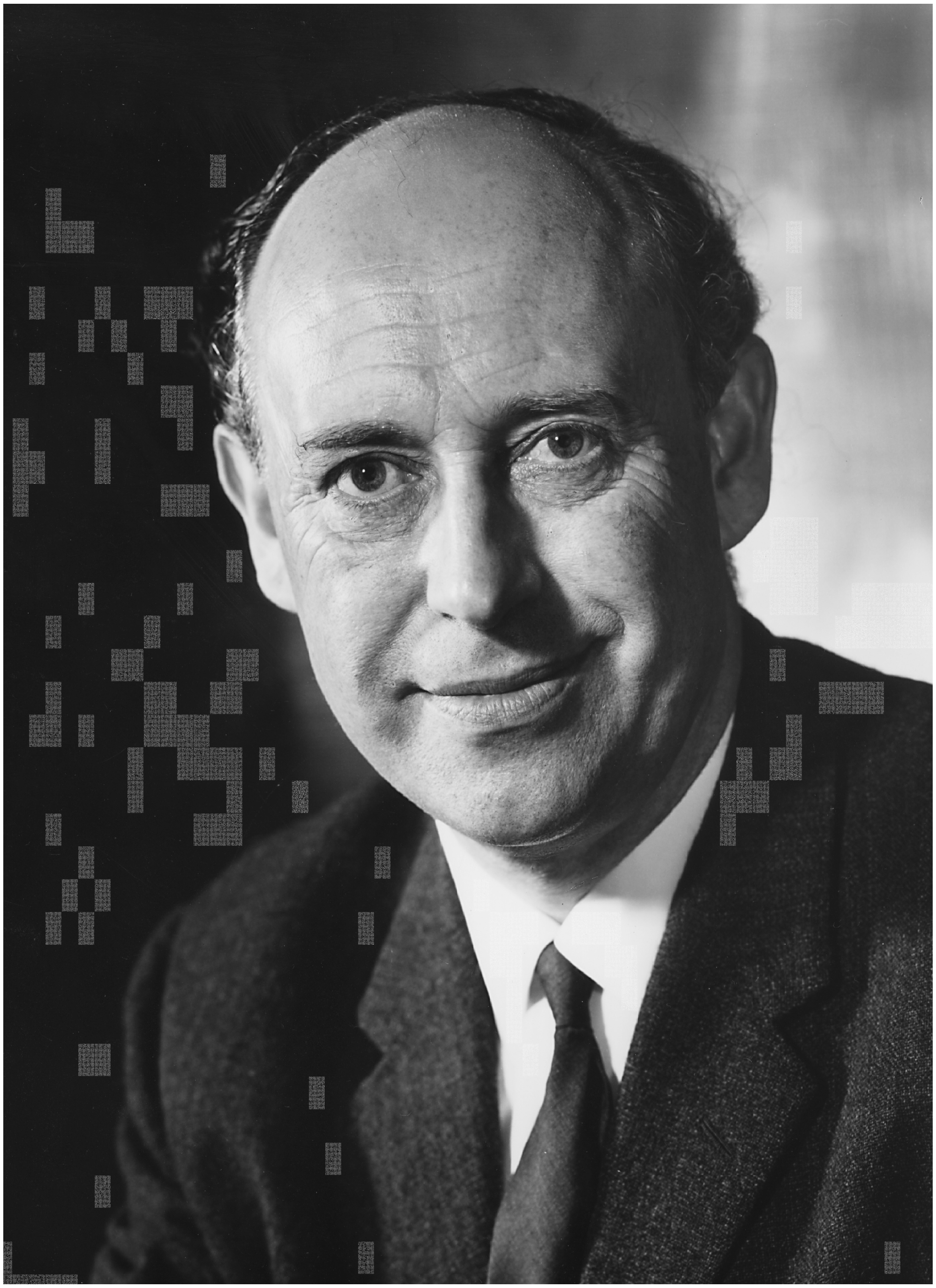

J. M. Hirst

JOHN MALCOLM HIRST, D.S.C.

20 April 1921 — 30 December 1997

Elected F.R.S. 1970

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John Malcolm Hirst, 'Jim' to all who knew him, was one of the leading aerobiologists of the twentieth century. He designed the Hirst spore-trap, an air sampler that made possible for the first time the routine quantitative and continuous estimation of spore and pollen concentrations in the atmosphere. Its use led to a breakthrough in the understanding of plant disease epidemics, to the identification of many airborne allergens and to the development of the national system of warnings for allergy sufferers.

Before embarking on his scientific career, Jim Hirst served with distinction in World War II as a Lieutenant in the Royal Naval Volunteer Reserve. His research years were spent at Rothamsted Experimental Station, where he became Head of the Plant Pathology Department, a post he held for nine years. He then became Director of Long Ashton Research Station, which he sustained and strengthened through a period of great change. He also worked for international aid bodies, giving valuable guidance to agricultural research centres in developing countries.

Early life

Jim was born on 20 April 1921 at Marston Green, a small village on the outskirts of Birmingham. He had one brother (Maurice Arthur Frank) who was five years older. Jim's father (Maurice Herbert), an associate of the Chartered Institute of Secretaries, worked for Sutton & Ash Ltd, Birmingham. He wrote reviews for Midland newspapers and magazines, specializing in exploration, especially maritime subjects, and was a Fellow of the Royal Geographical Society. During World War I he served as a Lieutenant in the Royal Horse Artillery. Soon after the war he developed a progressive, debilitating illness and the family moved to Solihull, where he could more easily travel to work by train. He died in 1928, when Jim was only seven.

Jim's mother, Olive Mary Hirst (*née* Pank), was a member of an old Norfolk family. Her grandparents had moved to Birmingham to join the burgeoning industrial population. In her younger days she was a promising singer. When her husband died she had a difficult life, with reduced income and no relatives living nearby. Her parents had by then retired back to Norfolk. She struggled to keep the boys at Solihull School, where Maurice had won a free place but Jim had not.

Holidays were spent mainly with Jim's grandparents, who had retired to West Runton on the north Norfolk coast. The beaches and countryside opened up a wonderful world for a rather solitary boy, his brother being too old to be a real companion. These seaside holidays had an enduring influence. When he was about ten, Jim volunteered one day to fetch a can of petrol for a fisherman, and was rewarded with a trip to sea. Thereafter he built up a strong relationship with the fisher folk, often going to sea with them. He later recalled, 'I learnt much about the weather, seamanship and boat handling all of which left me with a respect and love for the sea and rudiments of seamanship that proved valuable later'.

Jim did not shine at school. He attained a modest School Certificate but failed the Higher School Certificate. He was uninterested in the curriculum, claiming to have enjoyed only carpentry, botany and zoology. Looking back, he felt that his teachers could have done more to encourage or stimulate him. He hated games but in the Officer Training Corps he gained Certificate 'A' and held top rank. After leaving school he worked at a mixed farm in Warwickshire, which gave him a practical knowledge of farm husbandry. He studied through a correspondence course to retake 'highers'. The results in botany, zoology and geography gained him a County Major Scholarship, which 'did much to restore my self-esteem'.

Full-time employment enabled Jim to buy an old Excelsior motor bicycle. When World War II started, this enabled him to join the Warwickshire Constabulary as a volunteer air-raid despatch rider. Conversations in the duty room taught him something of a side of life that he had previously not encountered. Jim's call-up prevented his going to university, but joining the forces was delayed on compassionate grounds by the death of his brother in a sea-plane accident while flying in RAF Coastal Command. He was allowed time at home to help his mother attend to Maurice's affairs.

War service

Jim registered with a preference for the Royal Navy, and in 1941 he reported to HMS *Glendower* at Pwllheli, North Wales, Butlin's newly built holiday camp. Here he was in a chalet for eight ratings. When he discovered that the others had all 'done time', he thought it best not to mention his Warwickshire Constabulary days. After initial training he was posted Ordinary Seaman to HMS *Lauderdale* at Southampton, a new Hunt class destroyer. His action station was as a loading member of the forward 4-inch guns. He always maintained that the life and company in the fo'c's'le, although rough, were experiences that much broadened his understanding of people.

Once commissioned, HMS *Lauderdale*'s base was St John's, Newfoundland, from where she escorted convoys in the West Atlantic. On her return to Scotland, Jim was sent to HMS *King Alfred* at Hove for officer training. From Hove he went, at his own request, to join

Coastal Forces. This force of small fast boats included motor launches (MLs) and harbour defence craft (HDMLs). Its varied duties included mine-laying, mine-sweeping, convoy escort and clandestine coastal operations. Instruction on mines and torpedoes was held in the vacated Roedean Ladies' College. Jim rarely spoke about his war experiences, but he did enjoy being able to say, 'When I was at Roedean….'

In the summer of 1942, Jim joined 31st Flotilla as Junior Officer on ML 557, sailing to Algeria and later to Malta to escort landing craft for the invasions of Sicily and the subsequent landings on Italy's west coast and the French Riviera. His first command, at the age of 23, was of HDML 1246 on clandestine action along the Yugoslav coast. He then commanded ML 480 in the newly formed 41st Flotilla, whose task was mine clearance to establish safe channels into Italy's Adriatic harbours. A great hazard was the many mines fitted with floating snag-lines attached to the detonators. Lookouts in the bows could spot the snag-lines in calm water but in the choppy water encountered on their approach to Trieste, the technique failed to protect the leading boat. Fortunately it did not sink and was taken in tow by the second boat. Jim now had to take the lead in clearing a channel to the Istrian coast. After a very long and stressful day the depleted Flotilla became the first Allied shipping to enter Trieste harbour. For his part in the operation Jim was awarded the Distinguished Service Cross and one of his crew, Stoker W.H. Donovan, the Distinguished Service Medal.

With the end of hostilities Jim was posted back to England to take command of ML 155, one of a group supervising the German minesweepers that were clearing their own mines in the eastern North Sea. In 1946 Jim handed over command of ML 155 and returned to England to enter university. Some years later, his wife Barbara was able to buy ML 155's ship's bell as a gift to Jim.

University

On demobilization, Jim became eligible for a grant for ex-servicemen. Although strongly drawn to marine biology, he judged that there would be more employment opportunities in agriculture and therefore applied to study agricultural botany at Reading University. The indecision and lack of application of his later school years had gone; his war experiences had brought self-awareness and determination. Now his aim was to gain a good degree.

At Reading, Jim met Barbara Mary Stokes, who came from a Northamptonshire farming family and was a land girl during the war. Also awarded a County Major Scholarship, Barbara took a BSc in horticulture, and later an MSc while working at Rothamsted. They married in 1957 and had two daughters, Belinda and Susan.

A summer vacation spent as a voluntary worker in the Plant Pathology Department at Rothamsted had important consequences for Jim. He kept in touch with staff there and, on graduating with a first class degree, applied for a post then vacant at Rothamsted. He was interviewed by the Director and Dr P.H. Gregory (F.R.S. 1962), with whom much of the proposed work was to be done, and the day culminated in tea on the front lawn with the Head of Plant Pathology, F.C. (later Sir Frederick) Bawden, F.R.S. He took up his post on 1 July 1950.

Rothamsted Experimental Station

Food shortages during the war and the vulnerability of supply by sea had left the government determined to increase home food production. Research programmes with this aim were well established by 1950. Jim's task was to study the biology of the fungus *Phytophthora infestans*, which causes potato late blight, and to seek ways of improving control of the disease. Also joining Philip Gregory's team on the same day was Dr Fred Last, who was to study the epidemiology of cereal powdery mildew. Together with Gregory's assistant, John Stedman, all four worked in one room, the cramped conditions fostering much profitable scientific discussion.

Spore trapping

Gregory had arranged for experimental plots of potato to be planted at Rothamsted in 1950. The summer was wet and resulted in one of the earliest and most severe outbreaks of potato blight seen in East Anglia. This enabled Jim to become familiar with his subject quickly. He recognized the inadequacy of the only spore-trapping methods then available (deposition by wind on sticky slides or cylinders) because he often failed to detect spores when the amount of disease indicated that they could be expected.

Gregory, in his aerobiology studies (Gregory & Stedman 1953), had adopted the cascade impactor (May 1945) as the standard against which to compare other traps. This is a four-stage suction trap in which air, drawn through a narrow slit at each stage, impinges on a microscope slide on which airborne particles are deposited. Each successive slit is narrower, causing the air to travel faster so that progressively smaller particles are deposited. The impactor was not intended for extended use and slides soon became so overloaded with deposit that individual particles were indistinguishable. However, Jim realized that only a suction trap would give the efficiency of catch he required and pondered how to make a workable device. He saw that he need only use one stage of the impactor if he made the slide move past the entry slit, thus spreading and separating particles along its width, making identification and counting possible. In addition, the time of deposition of spores could be derived from their position along the slide. After much experimenting, he produced a model that could be tested the following summer. In the field the slide was removed each morning at 09.00 and a fresh one substituted. In the laboratory, the slide was given a permanent mount but before being stored it was scanned quickly for an initial assessment. The 'Hirst spore trap' (4)* (figure 1) not only proved to be reliable and practical, it yielded results far beyond expectations.

John Stedman recalls the excitement as the four occupants of the laboratory saw the first results. They were surprised by the diversity of fungal species, most as yet unrecognized (the trap caught spores down to 3 μm in diameter). Many species were also present in much larger numbers than previously imagined and most showed distinct periodicities related to the time of day, the season or the weather. In setting out to monitor *P. infestans* sporangia, Jim had developed a means of quantifying the air-spora in general. In great excitement he, Gregory and Stedman sought to identify species and plot hourly occurrence (7, 19). He was now as busily engaged in pursuing the spore-trapping work as on studying potato blight.

The traps showed that small basidiospores sometimes predominated. Previously, these had not been known as a component of the air-spora, yet for several weeks in late summer their

* Numbers in this form refer to the bibliography at the end of the text.

number exceeded that of all other species together, and they occurred mainly in the small hours of the morning. Gregory, an asthma sufferer himself who had worked in medical mycology, saw that the occurrence of the basidiospores could be related to the times when symptoms were displayed by some sufferers. Hirst and Gregory published the basidiospore information immediately, suggesting that the spores could be allergens, a hypothesis that was later substantiated (3, 5).

The great potential of the Hirst trap quickly became widely appreciated, particularly within the medical profession. Jim had many requests for the loan of a trap, few of which could be met, so the design was passed to Casella Ltd in 1953 for commercial production. Hirst traps were soon in operation at many hospitals and universities. The identification of many new allergens followed; regular monitoring of their numbers in the atmosphere began. Today's pollen-count warnings to hay-fever sufferers owe their origin in large part to Jim's innovative work. He continued to improve his design, and later, in conjunction with Burkard Ltd, produced a seven-day trap. Many hundreds of Hirst traps are now in use worldwide.

In 1954 Gregory left Rothamsted to take the Chair of Botany at Imperial College, although he returned four years later to be Head of Plant Pathology, when Bawden became Director of Rothamsted. With Gregory's departure, John Stedman became Jim's assistant and the two were to work together for the next twenty-one years.

Potato blight: spore dispersal and initial infection

Regular spore trapping established that *P. infestans* sporangia were commonly dispersed by wind, a possibility that had only been conjecture until then, and that when the disease became widespread in a crop, spores became general in the air above it (19). Jim found a marked diurnal periodicity in the occurrence of sporangia. Almost all were caught in daylight with peaks between 09.00 and 12.00, suggesting that sporangia were released as the sporangiophores dried (7). He confirmed that many spores were also present in drips falling from infected leaves on to lower leaves and soil during rain or heavy dew. About half the lesions on foliage arose from spores carried in drops from higher leaves (17).

When Jim started at Rothamsted, the question of how *P. infestans* survived the winter was still unanswered. Planting infected tubers might provide a major source of inoculum if the fungus could grow with the developing shoots to emerge above ground. In 1951 he established that this happened readily in pots in the greenhouse (2). For several years he planted up to 400 infected tubers among experimental plots of potato. Surprisingly, fewer than 1% of the tubers gave rise to infected stems. Usually this source of infection was insignificant, disease outbreaks almost always being initiated by spores from a more potent source outside the crop, such as discarded tubers on cull piles around farms (12, 13, 26). However, in one year, 1956, when there was little blight generally, although only six stems in his experimental area had lesions, the fungus spread from these to infect all plants by the end of July and they remained the primary source of infection. He warned that the relative importance of sources can vary and that it is always wise to avoid planting infected tubers (15, 27). He also observed that spores moved in water films in the soil to infect leaves that touched the soil surface (17, 20).

Potato blight: forecasting and disease control

Jim soon realized that monitoring airborne sporangia would not provide a means of forecasting when to spray against blight. Sporangia were present in the air on most days and the spread of disease depended on the weather being favourable for infection (19). He

Figure 1. The Hirst spore trap: an early model. Photograph courtesy of IACR-Rothamsted.

therefore made a full evaluation of the methods then being tried to detect periods of blight infection. The method widely used in England, developed by Beaumont (1947), indicated that the disease could be expected to increase within about 21 days of a two-day period when the temperature remained above 10 °C and the relative humidity above 75%. By 1950 the National Agricultural Advisory Service (NAAS), in conjunction with the Meteorological Office, was issuing 'blight-weather' warnings whenever these meteorological criteria were recorded at synoptic weather stations.

At the weather stations the readings were made in Stevenson screens 1.22 m above ground level, whereas Beaumont had derived his scheme from records made in a screen among potato foliage (16). Jim found that in wet summers, observations made at the two levels differed little.

In drier summers, the within-crop measurements predicted outbreaks more accurately but in these summers blight did not progress quickly so there was little to be gained from recording among foliage (11, 16). He assessed all the schemes then being tried in Europe and North America but concluded that the experience accumulated by regional pathologists in applying Beaumont's scheme in England and Wales made it the best then available. In 1955, Jim was awarded a PhD by Imperial College for his studies on blight forecasting (12).

To test whether leaves did remain wet at humidities of about 75%, Jim devised a dew balance. A potato shoot with its cut stem sealed into a water container on one end of a balance arm was matched by an equal weight of water in a second container at the other end, with the two connected so that the weights remained equal as the shoot transpired. Deflection of the arm by rain or dew recorded periods of wetness (9, 10). In concurrent work on apple scab (see below) the dew balance gave such useful results that a more robust model suitable for general use was developed by Hirst in conjunction with the Meteorological Office. In this model the shoot was replaced by a polystyrene 'leaf'. The instrument, called the surface-wetness recorder (18), became widely used.

From the beginning, Jim experimented with fungicide sprays to control blight (1). Along with others studying the same problem, he found that the copper fungicides then used gave the best control when applied just before an infection period. In practice, such timing was difficult to achieve even when using 'blight weather' warnings, so the best compromise was regular spraying once blight was in the locality (8,15). Best protection against tuber infection was achieved by killing the haulm when blight had affected 5% of the foliage, rather than by further spraying (39). Jim repeatedly stressed the need to understand the dynamic interplay between the growth of the crop and the progress of the pathogen when trying to decide on best ameliorative action (34, 38, 39).

In his studies of *P. infestans*, Jim discovered much about its epidemiology and answered many questions that had puzzled plant pathologists. He showed the value of a detailed knowledge of spore dispersal in evaluating disease control procedures (21). His findings had much practical benefit and his spore-trapping techniques stimulated a greatly increased interest in the wider field of aerobiology.

Potato tuber diseases

The early field experiments, in which tubers were regularly lifted and examined during the growing season, quickly alerted Jim to the importance of other pathogens. With Geoff Salt, he demonstrated the pathogenicity on tubers of the fungus *Oospora pustulans* (now *Polyscytalum pustulans*), first isolated from potato roots by Joan Moore at Rothamsted. Hirst and Salt found that the infection of tuber 'eyes' initiated outbreaks of skin spot on progeny tubers rather than the fungus that persisted in the soil or on roots (22) and that the incidence of infection varied with soil type and variety (11). In 1961, Geoff Hide was appointed to work with Jim on tuber diseases after Geoff Salt's secondment to work in the Sudan.

A survey by Hirst and Hide in 1962 of 200 seed stocks supplied by the Potato Marketing Board (PMB) showed that all samples carried *O. pustulans*, with about 75% of all tubers being infected (33). They found that chitting the seed (encouraging sprouts to form before planting) greatly reduced the number of eyes killed by the fungus and prevented much gappiness in crops (35). This survey led to hundreds of seed stocks being examined for the PMB in later years (37, 48). The work on tuber-borne diseases, sponsored largely by the PMB, then expanded greatly. Geoff Hide and co-workers concentrated on fungi (51, 57–59); Derek Lapwood's team studied problems caused by actinomycetes and bacteria.

In 1962, potato plants were propagated from stem cuttings in sterilized soil to produce tubers free from fungal infections (33). Experimental crops grown the following year from these tubers yielded up to 25% more than infected stocks (37, 53). The 'stem-cutting method' of raising foundation stock was introduced to the Scottish and Irish seed growers (40) and led to a large improvement in seed health (41). With the development of systemic fungicides in the late 1960s, the group began work on the fungicidal control of tuber-borne pathogens (47–50). A machine to treat seed tubers with fungicides was designed with the Scottish Agricultural Engineering Institute (52).

In 1959, Jim was the first to receive the newly instituted Jacob Eriksson Gold Medal awarded by the International Botanical Congress for outstanding work of international importance in plant pathology and mycology. In 1960 he visited New Zealand at the invitation of the Department of Agriculture to advise on research into the ecology of *Pithomyces chartarum*, the cause of facial eczema in sheep.

Apple scab

We return now to Jim Hirst's early years at Rothamsted. When in 1952 Ian Storey of the NAAS, Cambridge, learnt of Jim's spore-trapping technique he suggested that it be applied to the problem that apple growers were having in controlling scab (*Venturia inaequalis*). As with potato blight there was much debate, but little information, about what caused new infections each spring. The fungus produces both conidia and ascospores and their relative importance was sometimes hotly disputed. By trapping spores in Bramley orchards near Wisbech, Jim showed that, in spring, ascospores were the only spore type being dispersed and that they were often present in large numbers (14). He found that ascospores were being ejected from pseudothecia in dead leaves that persisted through the winter on the ground (8, 11). In orchards in eastern England, conidia appeared only in traps later in the season (6) and were dispersed by wind (8, 30).

During the next two years he made an intensive study of the ecology of *V. inaequalis* in apple orchards (23). He showed that the infection of leaves and fruit was determined largely by the ascospore inoculum produced within the orchard, initially from dead leaves on the ground. Jim constructed small wind-tunnels in which to elucidate the effects of leaf moisture and temperature on ascospore maturation and ejection (31). Where much leaf litter remained in spring, spraying the leaves on the ground with dinitro-*o*-cresol (DNOC), or the use of ammonium sulphate to hasten leaf decomposition, decreased the number of ascospores released by more than 90% (28, 32).

Mills & LaPlante (1951), from their observations in New England orchards, had suggested that the infection of leaves by ascospores occurred when the leaves remained wet for a period ranging from 30 h at 4 °C to 9 h at 15 °C. Jim, using first the dew-balance and then surface-wetness recorders, confirmed that Mills & LaPlante's figures applied in Wisbech orchards. From these data, NAAS and Meteorological Office staff developed an 'infection period' warning scheme (Preece & Smith 1961). Many growers bought their own temperature and surface wetness recorders to have immediate warning of when to spray. In 1957, Jim could claim, with the NAAS, that growers who timed their spraying according to the new criteria were achieving better control while using fewer than half the number of sprays applied formerly (17). In just a few seasons he had provided the information on spore dispersal that enabled the development of new control measures based on sound knowledge about the pathogen (21).

Vertical spore concentration profiles

In the 1950s, aerobiologists were attempting to develop a general description of dispersal processes and deposition gradients. To gain some insight into distant transport, Jim in 1956 began trapping from aircraft of the Research Flight of the Meteorological Office (15, 20). The first flights over the English Channel showed *Puccinia graminis* uredospores to be often common at 2700–4600 m when the trajectory of air masses was from southern Europe (24). This provided evidence (29) to support claims that infections of *P. graminis* f.sp. *tritici* on wheat did not originate from spores produced on the secondary host, *Berberis vulgaris*, but were the result of long-distance transport from continental Europe (Ogilvie 1961; Thorpe 1961).

Jim found that vertical profiles of concentrations over land of small spores and large pollen grains were the same and concluded that in the unstable air above land, gravitational settling was of little significance. However, out over the North Sea, the densest part of the cloud of pollen was 300–600 m lower than that of spores, suggesting that, in more stable air, differences in velocity of fall produced a different vertical distribution (43, 44). Flights across the full width of the North Sea, from England to Norway, showed that the 'dry-air' spores (those normally dispersed in dry conditions) of species such as *Cladosporium* and *Alternaria* and the 'damp-air' spores of species such as *Sporobolomyces* and *Tilletiopsis* were in discrete clouds, alternating with distance from the English coast, corresponding to their release during day or night (38, 45, 56).

Another aspect of the pattern of spore dispersal in which Jim was interested was that which took place on a much smaller scale within crops. He studied the movement of pollen from a sugar-beet seed-crop into a wheat crop and concluded that the filtering capacity of vegetation largely explained why the concentration gradients near sources were so steep (42, 54, 55).

Liberation of spores by raindrops

In the late 1960s, Jim began, with John Stedman, an intensive study of splash dispersal of spores. Early in his spore-trapping work, Jim had noticed that the onset of rain was usually accompanied by a marked increase in the concentration of 'dry-air' spores. With John he found that the air forced sideways by impacting drops blew spores into the air (25, 28, 36). He then studied dispersal in splash droplets of readily wetted fungal spores and found the dispersal gradients to be very much steeper than for dry dispersed spores (46, 49, 52).

Jim always hoped that one day he would be able to study splash and wind dispersal in controlled conditions in a combination rain-tower and wind-tunnel designed for the purpose. His opportunity came with the building of new laboratories at Rothamsted in the early 1970s. While the wind-tunnel was being commissioned, Jim moved to take up his post as Director of Long Ashton but the tunnel–rain-tower has since been used extensively at Rothamsted in numerous epidemiological studies (61).

Head of the Plant Pathology Department

In 1967, Philip Gregory retired and Jim succeeded him as Head of the Plant Pathology Department. Irrespective of his new administrative duties, he continued to follow his research interests with the teams he had assembled and kept close scrutiny on progress. He was a dynamic Head, who steered the department through a time of rapid expansion; the number of scientific staff more than doubled during this period. He also supervised a major building programme at Rothamsted. Jim had a marked capacity for hard work and sustained concentration. When on field work he often had to be reminded of mealtimes; lunch could be delayed well into the afternoon if taken at all.

In 1970, Jim was elected a Fellow of the Royal Society and was awarded the Research Medal of the Royal Agricultural Society of England for contributions to agricultural research.

Director of Long Ashton Research Station

In 1975, Jim was appointed Director of Long Ashton Research Station, on the retirement of Professor John Hudson. Long Ashton constituted the Department of Agriculture and Horticulture of the University of Bristol, so that he also became head of this department and Professor of Agricultural and Horticultural Science.

Long Ashton differed greatly from Rothamsted in its origins and objectives. The station was founded in 1903, by a group of west country farmers, to improve the standard of farm cider production. For many years its work focused on the husbandry and breeding of tree and bush fruits, on fruit preservation and on the manufacture of beverages from fruits. Like Rothamsted, Long Ashton was a grant-aided institute of the Agricultural Research Council (ARC), which controlled its scientific management. By the time of Jim's appointment, the ARC felt the need to extend the remit of Long Ashton to include arable crops and to decrease the effort on fruit growing and breeding. This was a response to shifts in the relative importance of the crops nationally.

A few months before his appointment, Jim had himself influenced this broadening of remit by recommending to the Joint Consultative Organization of the ARC and the Ministry of Agriculture, Fisheries and Food (MAFF) the potential of Long Ashton as a location for field experiments on cereal diseases. The mild, moist climate of the west country favours their spread. He found it ironic that the first two growing seasons after he moved to Long Ashton proved to be exceptionally dry!

Jim's expertise in plant pathology and field experimentation, in arable and orchard crops, was of much advantage at Long Ashton. However, he immersed himself fully in all the station's work. He was equally interested in the research on cider and wine quality, food preservation, apple, plum and strawberry breeding, ornamental shrub improvement, the use of trees as windbreaks and other 'non-plant pathological' topics. He gave thorough attention to the management of the staff, finances and facilities. He personally chaired the Field Experiments Committee, which considered 30–40 proposals each year. Few proposals escaped his critical comments, but these were always constructive and well received. All research papers intended for publication were thoroughly scrutinized. Many a manuscript was returned to the author covered in corrections and queries in his small but legible writing and ended up as a much more accurate and readable document.

His detailed interest in all the station's activities kept the staff on their toes, ensured high standards and made the most efficient use of facilities. Although running a 'tight ship', he did permit, and indeed expect, his senior staff to take full responsibility for their own bailiwicks and did not interfere unduly. He followed an 'open-door' policy, always prepared to see staff members, to listen to their views and to help with their work or personal problems.

As director, Jim was accountable to three governing bodies: the ARC, the Agricultural Committee of the University of Bristol and the Governing Body of the National Fruit and Cider Institute (NFCI). This might seem an untidy if not unworkable arrangement, but Jim in fact found it helpful. Although he was the first to acknowledge positive contributions from the ARC, for example in the design of buildings or the purchase of major equipment, he also expended much time in trying to overcome what he regarded as wrong decisions and damaging delays. His relationships with the university and the NFCI governors were much warmer; he enjoyed the regular meetings with them, and greatly valued their advice and support. In 1983, under his guidance, the NFCI was restructured and renamed the Long Ashton Members' Association (LAMA) so that this combination of industrial link and supporters' club could embrace arable farming.

In steering the scientific programme, Jim sustained many of the lines of research established by Hudson and his predecessors. At the same time he gradually transferred a number of staff to arable crop research. He handled this potentially awkward task well, selecting the people carefully, obtaining their cooperation and avoiding the need to 'frog-march' anyone. He encouraged formerly fruit-orientated scientists and farm staff to seek advice and facilities for field experiments from leading arable farmers in the west, from the Cotswolds to Cornwall. At Long Ashton some orchards were converted to arable fields and extra land was purchased. Within two or three years several projects were well established, including studies on the damaging effects and methods of control of *Septoria* in winter wheat, *Rhynchosporium* in winter barley, barley yellow dwarf virus and potato late blight.

An ARC Visiting Group, in 1976, fully supported the changes that Jim was making in the station's research programme and backed his building proposals to provide facilities for the engineering and plantations sections, for controlled climate experiments and for a new laboratory block. The Group recommended reorganization of the eleven separate sections into four divisions. Two of the divisions, food and beverages (headed by Fred Beech) and pomology (Iain Campbell), were formed quickly. It frustrated Jim that, largely because of administrative delays at ARC headquarters, he could not establish the Crop Protection Division (Keith Brent) and the Plant Science Division (Ken Treharne) until late 1979 and early 1982, respectively.

Towards the end of the 1970s he faced cuts in grant aid (the first of many), emanating mainly from the withdrawal of MAFF support for certain projects. He managed to save some of these by various financial 'rearrangements', notably the research on willows and the maintenance of the National Willows Collection, which have subsequently achieved international importance in relation to renewable energy production. The cuts eliminated staff vacancies that he had saved for the new divisions and delayed the building of the new laboratory block. The latter was completed shortly before his retirement. Every aspect of its planning and construction had been checked by Jim. It was aptly named the Hirst Building and was opened by Princess Anne in 1985 with Jim present.

In December 1981, the ARC publicly announced its intention to close the Food and Beverages Division and the Pomology Division. Their areas of work were said to be of lower priority than new fundamental work intended for elsewhere. It angered Jim and his staff that there had been no consultation with the station. In his Director's Report for 1982 (60) he made it plain that, although the right of the ARC to make selective cuts within their research programme was not disputed, he deplored its failure to consult the station, the University of Bristol, the scientists affected or the relevant industrial bodies, and its failure to present the reasoning behind the decision. Despite a spirited defence from Jim and his colleagues, with support from the university, the NFCI and others, the ARC strategy was confirmed and the closures took place. Much research had to cease, although some projects, together with the workers concerned, were relocated to East Malling Research Station and to the Food Research Institute. Some cider pomology research and the operation of the cider house were able to continue for some years through support from the MAFF and the cider industry.

Late in 1983, as financial cuts deepened, the closure of Long Ashton became an imminent possibility. Influenced by national surpluses in cereal production, the ARC decided to decrease its investment in arable crop research. Long Ashton was among several institutes under consideration for closure. Jim and his Division Heads submitted to the ARC a closely reasoned document presenting the scientific arguments for retention of Long Ashton. This, together with the recognition that Long Ashton's land and buildings were owned largely by the university, whereas other institutes under review were the ARC's saleable properties, persuaded the ARC to opt for the continuation of Long Ashton and also for the transfer to it of certain projects from the Weed Research Organization at Oxford and the Letcombe Laboratory at Wantage after the closure of these stations.

Jim devoted much of his last year as director to ensuring that the transfer of work to Long Ashton was well thought out and that the difficulties of the staff concerned were eased as much as possible. The transfers took place a few months after his retirement, but their orderly achievement and the subsequent success of the research projects owed much to his sensitive and thorough preparation.

In 1984 Jim decided to resign, some eighteen months ahead of his contractual retirement date. He thought it best for the station to continue under a new director, 'free from the memories of the battles I had fought'. Perhaps it was because of his battles with the 'establishment' that he did not receive a civil honour. He was appointed Professor Emeritus of the University of Bristol. A portrait in oils by Gerry Hicks, a local artist, was commissioned by the Governors of LAMA, and unveiled on the Members' Day in June 1985. It is an excellent portrayal, in which Jim chose to have the Long Ashton lands rather than the office as his background. The picture now hangs in the Committee Room, together with those of previous directors and of his successor, the late Professor Kenneth Treharne.

In his nine years at Long Ashton, Jim gave total commitment to leading its research and to managing its staff, facilities and finance. He not only sustained the station through troublesome times with determination but strengthened it by broadening its research, improving its organization and enhancing its facilities. Under his direction the research achievement and the scientific reputation of the station reached new heights.

Jim did find time to help a number of organizations beyond the station, through the membership of advisory bodies that are listed at the end of this memoir. His work for the Consultative Group on International Agricultural Research (CGIAR) involved visits to research centres in Syria, Mexico, Nigeria, the Philippines and Colombia, and to the World

Bank in Washington and the Food and Agricultural Organization in Rome. He gained much satisfaction from these missions, which not only gave refreshing, interesting breaks from his regular work but helped to make agricultural research in developing countries as productive as possible.

The years after retirement

Jim remained scientifically active as a consultant for a number of years. Much of his work was done abroad, assisting the CGIAR and other international aid agencies. His most sustained contribution was in guiding the work of the International Centre for Agricultural Research in Dry Areas (ICARDA) in Aleppo, Syria. In the 1990s he enjoyed using his aerobiological expertise once again, in doing some wind-tunnel development for the Burkard Manufacturing Company. He continued to receive honorary appointments and memberships from scientific organizations, as indicated in the list at the end of this memoir. He gained interest and pleasure from his election as President of the North Somerset Agricultural Society, and became actively involved in the organization of its large annual show.

As he gradually wound down his scientific activities, Jim could spend more time with Barbara in their delightful house and garden set in the beautiful Somerset countryside at Butcombe. Tending the garden, entertaining friends, talking to local farmers and attending agricultural shows, walking the collie dog and making and receiving visits to and from their married daughters (one living in Canada) and their three grandchildren all added up to a happy life in retirement.

Jim Hirst: the person

Jim was a big man physically and had a 'big' personality that embraced many powerful attributes. He was hard-working and determined, with an exceptionally good memory. In his own research and in his support of others he was motivated mostly by the prospect of a useful outcome for society, rather than just in satisfying curiosity or the pursuit of knowledge.

Bryan Harrison recalls, 'Jim never seemed in a rush, despite pressures, always retaining his seaman's/farmer's walk.' He had a subtle sense of humour and was rather fond of puns. His Presidential Address to the British Mycological Society was entitled, 'A Trapper's Line'. Before delivering a lecture to the Society of General Microbiology, prepared jointly with G.W. Hurst, Jim neatly introduced himself by saying, 'I'm the non-U Hirst'.

He could be forthright when he felt it necessary and disliked being bested or thwarted, but he was friendly and willing to help and was much liked by his colleagues. On Jim's retirement, the late Fred Beech, his Deputy Director, wrote in the Long Ashton Report, 'He was not an easy man. He enjoyed a fight and it did not matter whether you were a stranger or a colleague. He demanded you gave your best. It may seem paradoxical but he could also be sensitive to other people's feelings.' In an Appreciation for the British Mycological Society, Robert Byrde, the former Head of Plant Pathology at Long Ashton, described him as 'the epitome of courage, commitment and integrity'. He maintained this integrity even when it was to his own disadvantage. An autobiographical note prepared by Jim for the British Mycological Society includes the following telling passage:

> From school onwards (occasionally even in the Royal Navy) I have suffered from an unwillingness to accept the 'party line' of the establishment if I thought it to be wrong. This has quite often caused me to be unpopular with the establishment men but I am sure I would do the same again were there the opportunity. Although it probably did my career considerable harm at some stages, I am sure that it helped wonderfully to clarify my conscience.

Jim had little interest in sporting activities, apart from some small-boat sailing on family holidays and was not greatly involved in the arts or music. He enjoyed best the pleasures of his family life, home, garden and holidays with Barbara and the children. With Barbara he was most hospitable to friends and colleagues. Visitors much enjoyed his conversation and wry humour, along with a glass of Long Ashton perry or the excellent sloe gin that would be produced from a large oak chest.

Jim faced his last illness bravely, concerned not to be a burden to anyone. He remembered his friends with cheerful and affectionate Christmas cards written shortly before he died. Some three months after his death a Commemoration was held at Long Ashton. It was a poignant but heartwarming occasion, attended by many friends and colleagues, at which Barbara, Fred Last, Keith Brent and Mike Arnold gave short accounts of the many activities and achievements of this fine man.

Recognition by scientific societies

1959	Jacob Eriksson Gold Medal by the International Botanical Congress
1970	Elected a Fellow of the Royal Society
	Awarded the Research Medal by the Royal Agricultural Society of England
1971	Elected Chairman of the Federation of British Plant Pathologists
1972	Elected President of the British Mycological Society
1977	Elected President of the Association of Applied Biologists
1986	Elected Honorary Member, International Aerobiological Association
1988	Elected Honorary Member, British Society for Plant Pathology
1991	Elected Honorary Member, Indian Aerobiological Association
1991–94	President of the British Aerobiology Federation
1992	Elected Honorary Member, Association of Applied Biologists
1995	Elected Honorary Member, British Aerobiology Federation

Membership of advisory bodies

1976	Quinquennial Review Panel, International Potato Centre, Lima, Peru
1977–84	Agricultural representative on the Advisory Panel to the Commonwealth Scholarship Commission
1979–83	Member, later Vice-Chairman, of the Technical Advisory Committee of the Consultative Group on International Agricultural Research
1979–84	Consultative Committee of Directors of UK Food Research Institutes
1979–96	Advisory Committee on Forest Research, Forestry Commission, UK
1980	Genetic Manipulation Advisory Group, Plants Sub-Committee, UK

1982–83 Technical Advisor to House of Commons Select Committee on Foreign Affairs, Sub-Committee on Overseas Development
1982–85 Royal Society Committee on Engineering, Technology and Industries
1983 External Programme Review of ICARDA, Aleppo, Syria
1983–86 Member (later Chairman) of the Scientific Advisory Board of Twyford International
1984 Chairman, Management Review of ICARDA
Chairman of Specialist Panel, Overseas Development Administration, to evaluate agricultural research grants
1984–85 Study Group, Commonwealth Agricultural Bureaux, on the future of the scientific institutes
1984–87 Committee on Protected Environment Research, ICARDA
1985–87 Pesticide and Crop-Protection Database Committee, Commonwealth Agricultural Bureaux
1986–87 Consultant to World Bank, Sub-Saharan Africa Agricultural Research Review, Tree Crops
1987–88 Consultant to ICARDA, Research Strategic Plan
1989–90 International Service for National Agricultural Research, Tanzananian Agricultural Research
1991 Overseas Development Administration, review of Cocoa Research Institute, Ghana

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The frontispiece photograph was taken in 1970 by Godfrey Argent.

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