HARRY MARSHALL WARD (1895)

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HARRY MARSHALL WARD, 1854–1906

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During the closing years of the nineteenth century and the opening years of the twentieth Harry Marshall Ward was the most influential mycologist and plant pathologist in the United Kingdom.

His life can be quickly summarized. Born in Hereford, the son of a musician, he went to school in Lincoln and Nottingham, left school at age 14, and then attended evening classes in South Kensington, organized by the Science and Arts Department. His teachers there included TH Huxley and William Thiselton-Dyer, later director of Kew Gardens and whose assistant at South Kensington Ward eventually became. After a year at Owens College, Manchester, in 1878 he won an open scholarship to Christ's College, Cambridge, where he received anonymous support, it is now known, from one of TH Huxley's pupils, LA Lucas. Ward took a first class in botany in the Natural Science Tripos of 1879.

Then, as was the custom, he traveled to Germany to study the "new botany", and spent some time in Würzburg studying under Professor Sachs. When he returned to England he found a position at the Jodrell Laboratory in Kew Gardens. It was while he was there that he published his first paper, which was on the embryo sac in the Orchidaceae. At the end of 1887, he was seconded to Sri Lanka (then known as Ceylon) for two years to investigate coffee rust. On his return to the UK he was unemployed temporarily, but thanks to the influence of his former teacher Thiselton-Dyer, he soon obtained an appointment as Assistant Lecturer and Demonstrator at Owens College, Manchester, where he took over the teaching of vegetable physiology and histology from the then aging Professor WG Williamson (1816–1895). In the same year he was appointed to a fellowship at Christ's College, Cambridge, and married Frances Kingdon, the oldest daughter of Francis Kingdon of Exeter. Their only

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son, Francis Kingdon Ward (1885–1958), was also to be a botanist and plant collector.

Ward's first application for a professorship was unsuccessful: he had applied for the Regius Professorship of Botany at Glasgow University, vacant when Professor Balfour moved to Oxford. Soon thereafter, however, he was appointed to the new chair of botany in the Forestry Branch of the Royal Indian Engineering College at Cooper's Hill, Middlesex. Here he remained for the next decade until, in 1895, he was appointed to the chair of botany at Cambridge University, where he was to have a profound influence on the direction of mycological research. Unfortunately, during the early years of the twentieth century his health declined and he died at Torquay in 1906. The teaching of mycology and plant pathology was then taken over by his junior lecturer, FT Brooks (1882–1952), who remained at Cambridge all his life, trained more than 100 mycologists and plant pathologists, and was finally appointed to the Chair of Botany.

COFFEE RUST

Ward's two-year secondment to Ceylon to study coffee rust was occasioned by the promotion of Daniel (later Sir Daniel) Morris to the directorship of the Botanic Gardens in Jamaica. Morris had been working on the coffee rust, which had first been described by Berkeley & Broome from a single estate in Ceylon, but by 1875 had become widespread in that country. Morris had demonstrated that the rust could be checked by field workers dusting the plants with a mixture of lime and sulfur, but the trees soon became reinfected. Morris also showed that the infection was caused by windborne urediospores that infected every coffee plantation, because the jungle between the plantations had been cleared, which allowed the windborne urediospores to be widely distributed. Morris summarized his findings in 1882 in three official reports to the Linnean Society and, later, the *Quarterly Journal of the Microscopical Society*. Meanwhile, the coffee industry in Ceylon was destroyed, the Oriental Bank ruined, and the habit of coffee drinking in England declined as coffee was gradually replaced by tea. Marshall Ward attacked the problem comprehensively. He was the first to describe the teliospores and soon realized that coffee growing in Ceylon was doomed. Coffee rust is now prevalent throughout the Old World and during the past decade has been recorded in South America.

Ward found many mycological problems to study under the prevailing tropical conditions. He made pioneering investigations of the two sooty molds, *Meliola* and *Asterina* (on both of which he subsequently published), but his major success was to elucidate the status as a lichen of the epiphyllous *Mycoidea parasitica [Cephaleuros virescens* Kunze], first described by DD Cunningham in 1877.

On the way back to England, Ward paid a short visit to Anton de Bary at Strasburg. In general, de Bary endorsed Ward's investigations on coffee rust.

Marshall Ward was elected to the Royal Society in 1888, and in 1890 he was invited to give the Croonian Lecture. He chose to deal with the relation between host and parasite in plant disease and, in particular, with the way in which the balance is turned when one organism is invaded by another.

While at Cooper's Hill he regularly took parties of students to Kew Gardens to visit the arboretum. He also published a series of books, including: *The Oak,* 1892; *Timber and Some of Its Diseases,* 1897; *Grasses, A Handbook,* 1901; for the Society for the Propagation of Christian Knowledge, a little book, *Diseases of Plants,* 1894; and partly posthumously, *Trees, A Handbook of Forest Botany,* 5 vols, 1904–9 (Volumes 4–5 were edited by Percy Groom). Further, he edited H. Hartig's *Textbook on the Diseases of Trees,* 1894, and made a translation of J. Sach's *Lectures on the Physiology of Plants,* 1897.

Also at Cooper's Hill, Ward elucidated the life history of *Entyloma ranunculi* and demonstrated that conidia were part of the life cycle, as G. Winter had previously suggested. He investigated potato blight and showed that the development of zoospores was delayed (or arrested) by direct daylight. But the climax of his research was the now classical paper on the lily disease caused by *Botrytis cinerea,* which later became the starting point for William Brown's (1888–1975) detailed studies on the pectinase enzyme produced by *B. cinerea* that he undertook at the Imperial College of Science in the 1920s.

Ward studied the yellow juice from Persian berries (*Rhamnus infectorius*), which a dyer had found was more potent when the berries were crushed. Ward demonstrated that the enzyme involved was localized in the raphs of the seed. He also studied the problem of leguminous plants with tubercular swellings on their roots, and described how he induced the tubercules artificially. He noted that the bacteria involved entered the roots via the root hairs. This accounted for why leguminous plants carry away from soil more nitrogen than could be accounted for by fixation of atmospheric nitrogen present in the nodules.

In 1887 Thiselton-Dyer had been given a sample of Ginger-beer plant that seemed to have an affinity to Kephir of the Caucausus. Earlier, Bayley Balfour had concluded that the Ginger-beer plant was a mixture of a yeast and a bacterium. Ward demonstrated that the essential components were a yeast (derived from the sugar) and a bacterium (from the ginger). Both organisms were anaerobic: the yeast produced carbon dioxide but little alcohol and the bacterium used the carbon dioxide produced by the yeast. When working together, the carbon dioxide might activate the bacterium and its removal is of benefit to the yeast. Ward established the principle of symbiotic fermentation, and he showed that the Ginger-beer plant is comparable to a gelatinous lichen and succeeded in reconstituting it.

Ward made detailed studies of bacteria. He contributed the entry on Schizomycetes to the 1889 issue of the *Enclycopaedia Britannica* and, in the 1902 issue, included some of his own results in his entry on Bacteriology, which VH Blackman subsequently updated for the 1910 edition.

During the 1890s, Ward undertook a major bacteriological examination of Thames River water on behalf of the Royal Society. The three interrelated problems were: (*a*) the composition of the bacterial flora of Thames water; (*b*) the possible inclusion in this flora of pathogenic bacteria; and (*c*) if no such pathogenic bacteria were present, the cause of their elimination. It was already known that water stored in large reservoirs cleared itself of bacteria by subsidence and that exposure to direct sunlight is fatal to bacteria in a liquid medium. As to the second problem, Ward determined the effect of adding the anthrax bacillus to Thames water, although Pasteur had already shown that airborne anthrax bacilli are dead. The contamination of water near the source of a stream is very low and progressively increases due to the addition of bacteria from drainage, etc. Marshall Ward was responsible for the bacteriology that involved several thousand individual cultures, and he found by the use of a spectrum that it was light of short wavelength that was responsible for the death of bacteria.

Marshall Ward's experience with coffee rust left him with an interest with rusts to which he kept returning at intervals during his life. While at Cambridge, Ericksson's suggestion of "mycoplasm" (a combination of the host and a pathogen) attracted Ward's attention, as it did that of ES Salmon, at Wye College in Kent, in connection with the powdery mildews. Ward was, however, able to demonstrate that the idea was mistaken. Later, while still at Cambridge, Ward believed, in relation to the rust of brome grasses, that by growing the brome rust (*Puccinia recondita*) on certain lines of brome grass, the rust adapted itself to the host, which it was then able to infect. The idea was finally shown to be without foundation by Bean, Brian & Brooks (1) who demonstrated that several different physiological races of the brome rust were involved.

In the laboratory Ward was a skillful manipulator and also a competent artist able to illustrate his own papers. His main fault was a compulsion to leave no avenue unexplored (which is the equivalent of Professor Chamberlain's "method of multiple working hypotheses"). By doing this, he undertook much laborious work but he was never dissatisfied if any avenue he explored proved to be a dead end.

At Cambridge, as was the custom, Marshall lectured to the first year class. He was a popular lecturer and frequently drew on his wide experience to provide pertinent illustrations. He acted as examiner to the Universities of London and Edinburgh, and he served terms on the Council of the Royal Society (1885) and the Linnean Soociety (1887). He was also president of the

Botanical Section of the British Association at Toronto in 1887, of the British Mycological Society (1900–1), and of the Cambridge Philosophical Society in 1905. He was appointed by the Council of the Royal Society to represent the Society at the International Congress of Botany in Vienna in 1905. While carrying out this duty his health deteriorated. He made a leisurely return to England, which included several weeks at clinics in Carlsbad and Frankfurt, but he died suddenly at Torquay on 26 August, 1906, and was buried in St Giles Cemetery, Cambridge. *Wardina* Arnaud (1918); *Wardomyces* F.T. Brooks & Hansford (1923); *Wardinella* Batista & G.E.P. Peres; and *Wardomycopsis* S. Udagawa & K. Furuya were named in his honor.

ACKNOWLEDGMENTS

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