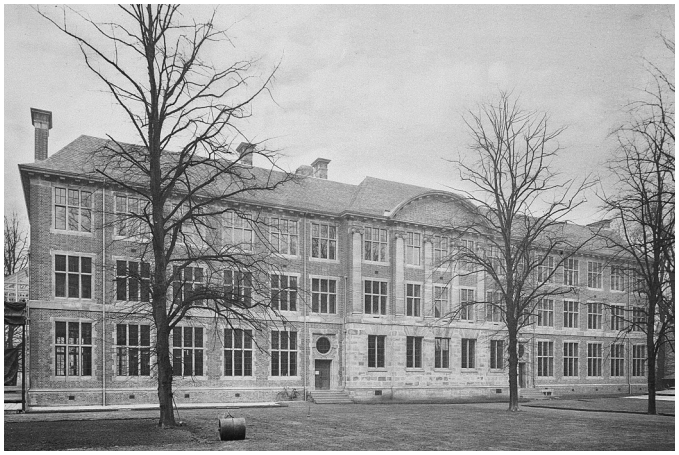
100 Years of Plant Sciences in Cambridge: 1904–2004

Introduction

This booklet celebrates the centenary of the University building that houses the Department of Plant Sciences or, to use its earlier name, the Botany School. It also commemorates the life and work of Harry Marshall Ward, whose vision led to the opening of a new building by the King and Queen on 1 March 1904. The story of Marshall Ward is both remarkable and tragic. He was forced to leave school at 14, but managed to get to Cambridge, supported by an anonymous benefactor. Soon in the fast stream, he was elected FRS at the age of 34. He transformed his branch of botany, and was one of two outstanding candidates when elected to the Cambridge Chair in 1895. He had diabetes, and died at the age of 52, only two years after the new Botany School was officially opened.



The north front of the new Botany School in 1904

During the years 1904–14 the Botany School had only eight members of Academic Staff at a time, but among them were those destined to dominate the development of their respective sub-disciplines in Britain for the first four decades of the 20th century. Their students filled many of the Chairs in other Universities. When the International Congress of Botany was held in Britain in 1930, Cambridge was the natural venue. In the second half of the 20th century, when there were so many other Botany Departments in Britain, Cambridge inevitably played a less dominating part. Nevertheless some members of staff attracted an exceptionally large proportion of the young researchers who would occupy leading roles in the development of the subject, while others were influential internationally through their writings.

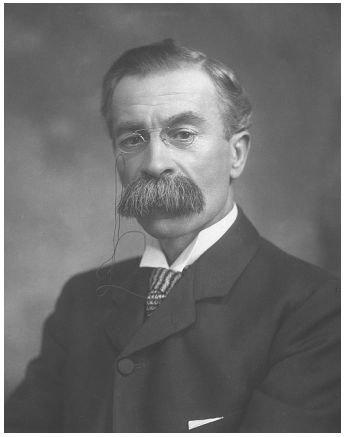
The first two sections of this booklet cover the life of Marshall Ward, and the old and new buildings for Botany. There are then sections dealing with the many achievements in Cambridge over the last 100 years in seven major sub-disciplines. In these sections our emphasis is on the impacts of the earlier researchers, and we say little about those who are doing outstanding work now. Next there are sections on the parts played by the Assistant Staff, and by the Botanic Garden, for teaching and research across the whole subject. The present Head of Department and the present Professor of Botany provide an account of the current position of the Department, and the way forward. We end on a lighter note, based on the semi-scurrilous *Tea Phytologist*, which is nearly as old as the building. The initials at the end of each section indicate the author chiefly responsible.

We are indebted to Professor Peter Ayres of Lancaster University for access to his biography *Harry Marshall Ward: the Fungal Thread of Death*, to be published by the American Phytopathological Society in 2004. We also acknowledge permission from various organizations and individuals to publish photographs and drawings. In some cases we have been unable to find the photographer. We thank our colleagues for correcting our draft accounts.

Peter J Grubb E Anne Stow S Max Walters

Harry Marshall Ward and the new Cambridge Botany

It was very much the vision of Harry Marshall Ward which led to the opening in March 1904 of a new Botany School that was generally acknowledged at the time to be the best equipped in Britain. When Marshall Ward was appointed to the chair in 1895, the state of the Department was far from satisfactory. He took over from CC Babington, who had been appointed to the chair in 1861 in succession to JS Henslow, the man who was such a vital inspiration to the young Charles Darwin. During his long tenure of the chair Babington ignored the exciting new discoveries being made in Germany in both the morphology and the physiology of plants, and showed interest only in his Herbarium. Under the old statutes he was elected for life, and he clung on until the age of 87. The Department was housed in inadequate buildings (see p. 4), and it clearly presented a challenge to any successor to the Chair.



Harry Marshall Ward

A key step toward modernization was the appointment of SH Vines as a Fellow and Lecturer of Christ's College (Charles Darwin's old college) in 1876. He spent the summer of 1877 with Julius von Sachs in Würzburg. On return he began a very successful practical class in Botany in a room made available to him by Sir Michael Foster, Professor of (Animal) Physiology and amateur botanist and gardener. The room was equipped for observation and experiment at Vines' personal expense! When the young Marshall Ward came up to Christ's in October 1876, he was stimulated more by Vines than by anyone else. He had already experienced Vines' enthusiasm at the newly formed Science School in South Kensington, where TH Huxley was teaching the new evolutionary biology and training teachers for the rapidly expanding schools throughout the country. Here W Thiselton-Dyer, soon to become Director of the Royal Botanic Gardens at Kew, was teaching the botanical parts of Huxley's Biology course with MA Lawson and Vines as his juniors. Thiselton-Dyer was later to recall the impression the new young student made on his teachers:

'Vines and I soon discovered that we had got hold of a man of exceptional ability. In the examination at the end of the course he soared away from all the other students and stood alone at the head of the first class. The strain of the work on both teachers and students was certainly severe: there was the keenest competition amongst the best men to respond to the demands made upon them, and the tension was sometimes rather acute. On one occasion Marshall Ward fainted at his work from no other cause I think than over-excitement.'

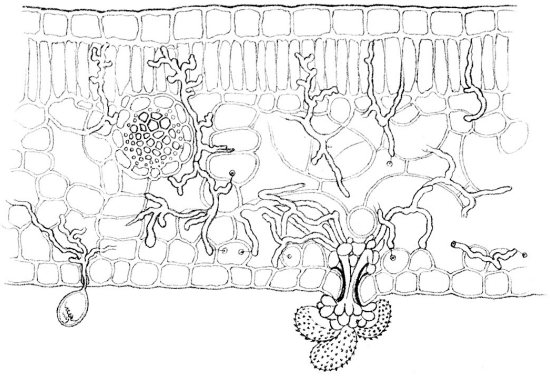
It is reasonable to speculate, in view of Harry's death at the age of 52 through diabetes, that he could already have been showing symptoms of the disease in his student days.

When Marshall Ward decided to aim for the Chair at Cambridge is not clear, but he was certainly unhappy with the very small salary he received as Professor of Botany at the Royal Indian Engineering College at Cooper's Hill, London, a post he held for ten years. When the Cambridge Chair was finally advertised in 1895, two of the most obvious candidates, both Cambridge educated, had already taken Chairs at other universities: Vines at Oxford and his pupil FO Bower at Glasgow. Vines was an Elector. Francis Darwin, Charles Darwin's third son, had become a Lecturer in 1884, and the Reader in Botany in 1888 when Vines left for Oxford. From 1892 he was running the Department as Deputy to Babington, but he was also active at the highest levels in science in Britain (Foreign Secretary of the Royal Society, President of the British Association, knighted 1913). In 1895 he was an Elector, not a candidate for the Chair.

There was a strong internal candidate: Walter Gardiner, five years younger than Marshall Ward, also trained under Vines and Sachs and nurtured by Foster, made a Lecturer in

succession to Darwin from 1888, a pioneer in the study of plasmodesmata, and elected FRS at the age of 30. He had also revived the Botanical Museum and greatly extended the collection. Ruled out on grounds of ill health, he was bitterly disappointed by the verdict and resigned in 1897, thereafter working in a laboratory at his home.

The new Cambridge Professor of Botany represented a stark contrast to his two predecessors, Babington and Henslow, who were both of 'gentlemanly stock' to whom an Oxbridge chair would have been an entirely normal way of life for any reasonably intelligent man. Harry Marshall Ward was the eldest child of Francis and Mary Marshall Ward. He was born in 1854 in Hereford, where his father, originally from Lincoln, held the post of Lay Clerk at the Cathedral, taking a daily part in the choral services for the modest salary of £50 per annum. Money was always short in the Ward household, and Harry's father, who styled himself 'Professor of Music', supplemented his salary with earnings from music pupils, and from performing the sentimental ballads so popular in Victorian times. After returning to Lincoln, the family finally moved to Nottingham where, when Harry was 14, a severe financial crisis terminated his schooling, and he was obliged to take a job as an office clerk.



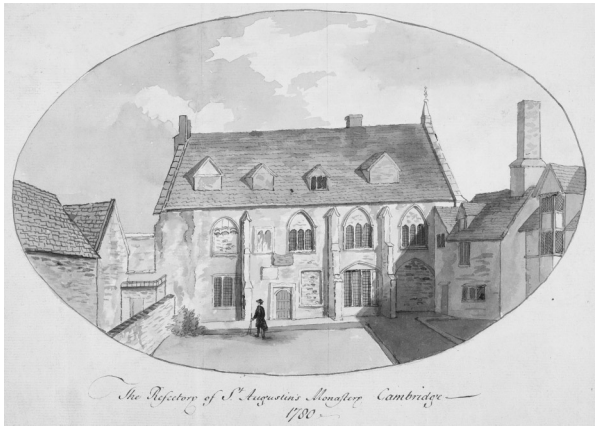
Part of a section of a coffee leaf showing on the underside uredospores of *Hemileia vastatrix*, the cause of the leaf-fall disease (from *Quarterly Journal of Microscopical Science* 1882)

Although music might have been Harry's choice of profession – with a fine baritone voice he retained a love of music throughout his life – through evening classes taken after work Harry seems to have developed in adolescence a strong interest in natural science. This bore fruit when in his twentieth year he won a place as a full-time student at Huxley's Science School mentioned above. It was here that Harry became a friend of Louis Arthur Lucas, son of a rich Jewish business man in Manchester, and through him spent a term in 1875 at Owens' College in that city, where he sat at the feet of Professor WC Williamson, an influential teacher and a pioneer in palaeobotany. It seems certain also that it was in Manchester that he met his future wife Selina Kingdon, to whom he was engaged for seven years before their marriage in 1883. Lucas, who died tragically in 1876 on an African expedition aged only 25, had become Harry's benefactor. Under his will he left money at Mortlock's Bank in Cambridge to pay for Harry's course at Christ's.

Harry graduated with First Class Honours in 1879, and went immediately to Würzburg to experience the new German botany for himself under Sachs. Although we learn from one of Harry's letters that he was not favourably impressed by Sachs, whom he found to be 'a narrow and intolerant man, who rarely stirred from his laboratory', Harry's enthusiasm for the new plant physiology pioneered by Sachs was such that he was to publish in 1887 in three sizeable volumes his own translation of Sachs' *Lectures in Physiology*. His greatest tribute to Sachs, however, was in his own research in which he brought a physiological perspective to plant pathology and helped to establish a new discipline.

By 1880 the leading British botanists at Kew, particularly Thiselton-Dyer, had taken on board the German advances, and were increasingly directing young British talent toward economically important research and administration in the British Empire, then at its height. In that year Marshall Ward was sent to the then Ceylon to work on a major disease of coffee, and did an outstanding job in establishing that the cause was the rust fungus *Hemileia vastatrix*. In 1882 he visited Anton de Bary (the doyen of mycologists and plant pathologists) in Strasburg on the way home to an Assistant Lectureship at Manchester. In 1883 he was elected to a Fellowship at Christ's, in 1885 to the Chair at the Royal Indian Engineering College, and in 1888 to the Fellowship of the Royal Society. His fitness for the Chair at Cambridge in 1895 could not be questioned. SMW

Old and new buildings for Botany

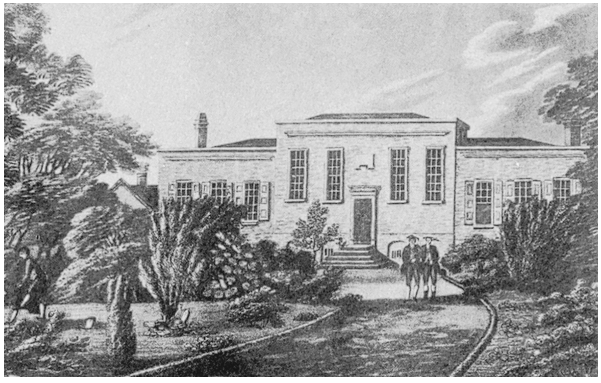


The first building made available for teaching and research in Botany at Cambridge: the refectory of St Augustine's Monastery, known in the 1760s as 'the Great House' in Free School Lane, and believed to have been demolished soon after 1784 (by permission of the Syndics of the Cambridge University Library)

The Chair of Botany at Cambridge is the equal-fourteenth oldest in the University, being established in 1728. In the 18th and 19th centuries the needs of the Professors of Botany had been relatively well met, certainly compared with those of Professors in the other sciences. Most of them had shared cramped buildings in what is now known as the Old Schools before gradually moving their teaching and collections to the New Museums Site in the second half of the 19th century. However, by the end of that century the accommodation for Botany had become woefully inadequate and unsuitable. A new building was desperately needed.

In 1760 Richard Walker, Vice-Master of Trinity College, bought the Manor House in Free School Lane (formerly the refectory of St Augustine's Monastery) together with five acres of garden and gave it to the University for a Botanic Garden. Dr Walker directed that the room on the ground floor of 'The Great House' should be used for the reading of lectures on Botany, and that an unfurnished room upstairs should be used for books on botany and the *Hortus Siccus* (herbarium). On 18 April 1763 the *Cambridge Chronicle* recorded, ' at the Great House in Free Scole Lane, a course of lectures will be given by T. Martyn, M.A., Prof". This appears to be the first University building assigned to the teaching of botany.

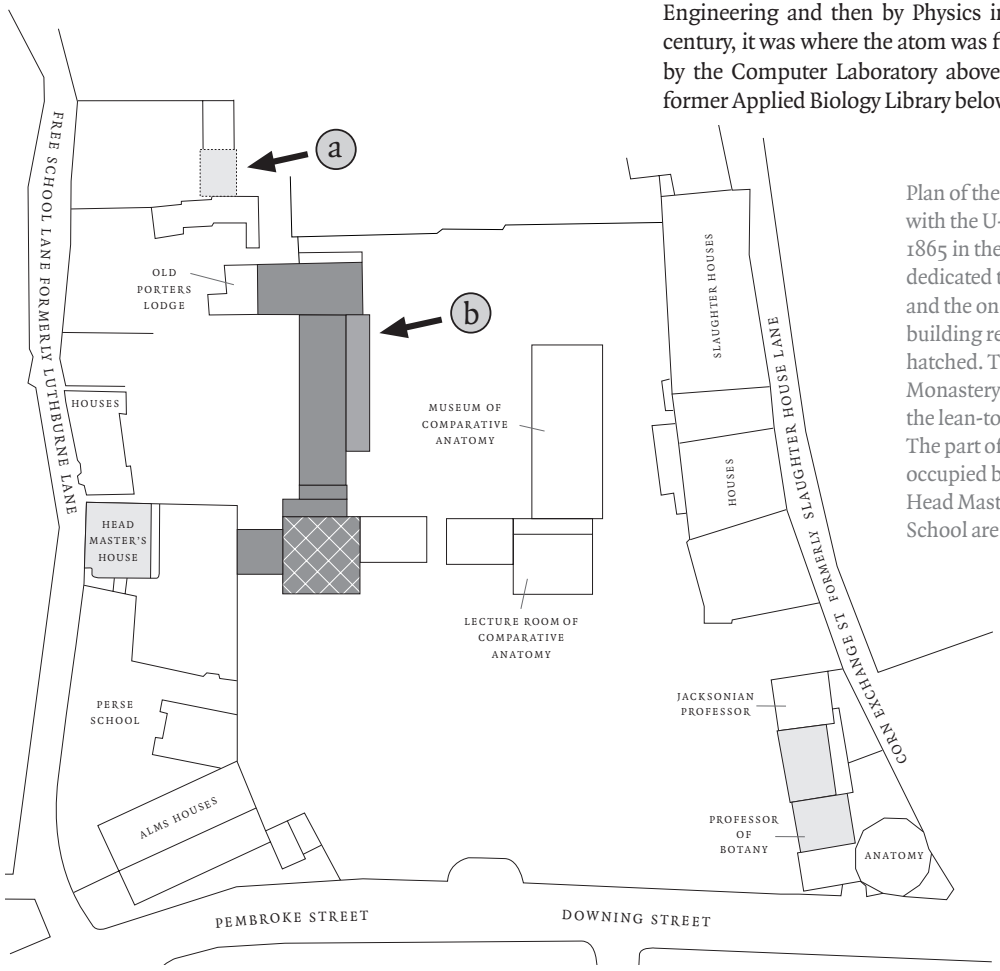
In 1784 the site of the Great House was leased to Mr John Mortlock. In its place the University built in 1786 a single storey building at the south-east corner of the Old Botanic Garden (see map on p. 5). It incorporated a lecture room, 40 x 28 feet, and rooms at the two ends for the Professor of Botany and the Jacksonian Professor of Natural and Experimental Philosophy (then a chemist) respectively. From Harraden's engraving of 1800 (shown below) it appears to have been a sturdy and well-lit building, but it was not liked. It was here that Thomas Martyn and then, after a lapse of some years, JS Henslow lectured and built up their collections. In 1832 the building was extended to include a lecture theatre for Anatomy, but in 1901 it was demolished and replaced by the Humphry School of Medicine building now occupied by Zoology.



The second building provided for Botany, was erected in 1786 at the other end of the Botanic Garden from the first building, and was demolished in 1901

The south front of the Salvin building of 1865; Botany occupied the part on the extreme left, still standing today

The removal of the Botanic Garden to the south of the city in 1846–52 released a large area for the University to start building suitable rooms for the teaching of science. In 1865 Anthony Salvin designed a range of buildings in the centre of the site on three sides of a square with an opening to the north. These buildings were to house Botany, Comparative Anatomy (including Zoology), Mathematics, Mineralogy, the Jacksonian Professor and the Philosophical Society's Library (see map below). The only part of this complex to survive is the southern end of the west wing, originally assigned to Botany, now immediately west of the Cockcroft Lecture Theatre. Occupied by Engineering and then by Physics in the first half of the 20th century, it was where the atom was first split; now it is occupied by the Computer Laboratory above, and a book store for the former Applied Biology Library below.



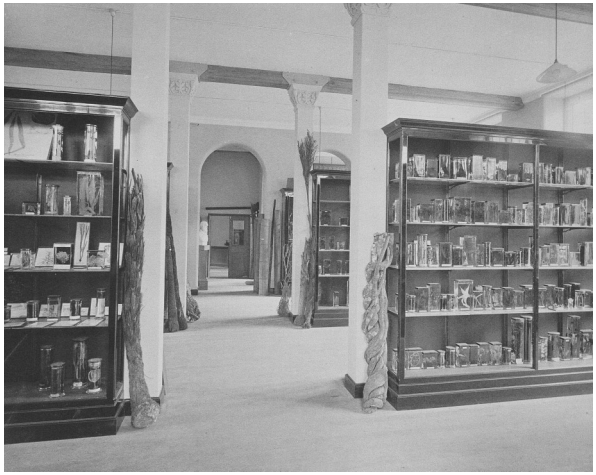
Plan of the New Museums site in 1870 with the U-shaped Salvin building of 1865 in the centre: the block of rooms dedicated to Botany is shaded darkly, and the one section of the Salvin building remaining today is cross-hatched. The position of St Augustine's Monastery is shown by (a), and that of the lean-to laboratory for Botany by (b). The part of the 1786 building formerly occupied by Botany and the former Head Master's House at the Perse School are shaded lightly.

By 1870 Botany had ceased to occupy the 1786 building. At the time much of the teaching in all sciences was done from museum collections, and the Old Botanic Garden was renamed the New Museums Site. During the next thirty years the University acquired most of the property bordering on the old Garden Site, but it became increasingly congested as new buildings were put up on the south-western and southern sides for Engineering, Chemistry, and Medicine, and on the north-eastern side for Human Anatomy and Physiology. Only Geology remained at the Old Schools.

In 1890 Botany was granted the use of the building formerly occupied by the Headmaster of the Perse School (see map on p.5). Nevertheless when Marshall Ward took over as Professor in 1895 the department's accommodation was spread over the western third of the site with only the Herbarium in purpose-built accommodation, and units like the Library divided into disconnected areas and with corridors as labs and rooms as corridors. By 1897 Marshall Ward was already a member of the Sites Syndicate set up by the University in 1896 to prepare a scheme for the appropriation of the sites to be purchased from Mortlock and from Downing College and other sites as necessary. In his own report to the Syndicate he suggested two approaches for the accommodation of Botany, a well-argued but convoluted plan for improving the existing botany buildings and a straightforward proposal for a removal to a new building built on the land recently acquired from Downing College, i.e. that south of Downing Street. Initially the University gave priority to the building of the Sedgwick Museum, influenced no doubt by the desperate need for Geology to move from the Old Schools and also by the magnificent response to the Adam Sedgwick Memorial Appeal. The architect was to be Sir Thomas Jackson who also had responsibility for the adjacent Squire building for Law (now the library of Archaeology and Anthropology). Marshall Ward's efforts were rewarded in 1900 by the University agreeing to fund a new building for Botany at a cost of over £25 000. Designed by WC Marshall, of the London architects Marshall and Vickers, it was to be situated on the Downing Site opposite the main gate. Marshall was a graduate of Trinity, a favoured architect for new University buildings in Cambridge at the time, and a friend of Francis Darwin. Marshall and Jackson erected their buildings simultaneously and employed the same Clerk of Works.

The new Botany School was erected on a steel frame, a technique just then coming into general use for large buildings. As shown below, the girders were left naked in the Elementary Laboratory but were boxed and even given 'capitals' in the Museum !

The Elementary Laboratory in 1904



The Museum in 1904, looking west (where the Herbarium has been since 1952)

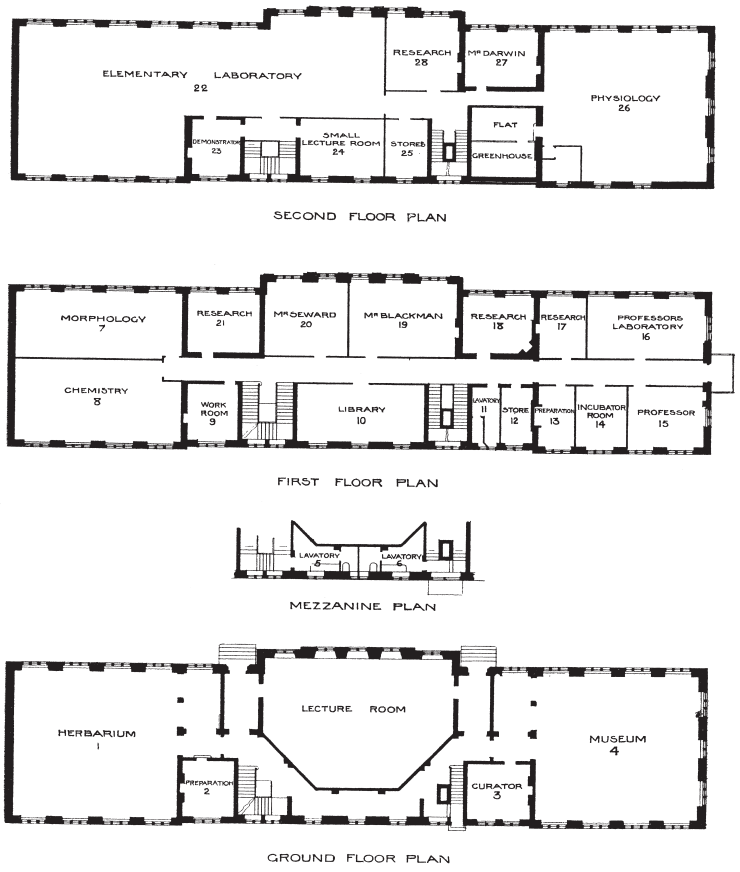
The Sedgwick Museum, the Botany School and the Squire Law building, together with the Humphry School of Medicine on the other side of Downing Street, were formally opened by King Edward VII and Queen Alexandra on 1 March 1904. Reports appeared in the *Illustrated London News*, *Nature*, the local press and *The Builder*. In the latter the Editorial for 5 March 1904, presumably written by the Editor, HH Statham, assesses the new building ' Mr Marshall's botanical building cannot be accused of being designed piecemeal; it presents a centre feature with a segmented gable of Georgian fashion, and wings pierced regularly with two tiers of large mullioned windows. Nothing could be simpler, but it looks rather bald, and one feels ... that the ancient buildings [of Cambridge University] have the advantage in dignity. The windows do their duty; the interior is admirably lighted; but the external appearance is for a University building rather commonplace.'

Later (in June) the American journal *Popular Science Monthly* commented 'The building for the botanical school is less imposing than the Sedgwick Museum, but appears to secure good effects by its proportions.... the building has doubtless been made for the laboratories and lecture rooms, not as sometimes happens in university architecture, imitated from a model built at a time when there were no laboratories. A hundred years hence such buildings will probably appear in better taste and more truly beautiful than our gothic and classic imitations, built without reference to their uses'.

Marshall Ward was well pleased with the new building. 'It is a piece of construction most satisfactory in every way, and presents not only sufficient architectural beauty to satisfy many who were apprehensive on that score, but has a simple and quiet dignity of its own which justifies its position on the important site it occupies. Internally it is exceedingly good...'

The lectures and practical courses taught in the first year after the official opening are shown overleaf. Note that the individual courses are priced separately (as they were until 1926), and that the Head of Department lectured to the First Year three times a week through all three terms ! RH Biffen, then lecturing to Botany students, was distinguished for his breeding disease-resistant wheat, became the first Professor of Agricultural Botany in 1908, and was knighted in 1925.

In 1928 the International Education Fund (founded by John D Rockefeller Junior) gave over a million pounds to the University toward the new building for the University Library and for developments in Agriculture, Biology and Physics. Botany's share was £108,500 for two new sub-departments



The architect's plans for three storeys of the new Botany School of 1904

for research into Plant Physiology, and Mycology and Bacteriology. In addition to new staff and research endowments the money contributed toward an extension (designed by TA Lodge of Lancaster and Lodge) to the west of the main building put up in 1933–34 to house the new sub-departments. Incidentally the new building included, on a mezzanine floor, research rooms soon to be devoted to Genetics. It was opened on 22 October 1934 by King George V. In addition a field laboratory for Botany was erected in the 'Rockefeller Field' of the University Farm on the north-western side of Cambridge.

Since World War II there have been many small changes in the assignment of rooms, and many steps in modernization, but there have been three major campaigns of refurbishment. In 1949–53 there was a large-scale reorganization of the accommodation on the ground floor of the main building. The Library was greatly enlarged and moved downstairs to what had been the Herbarium, the Herbarium was moved into what

List of Lectures proposed by the Special Board for Biology and Geology, 1904–1905

Michaelmas Term, 1904	Lent Term, 1905	Easter Term, 1905
II. BOTANY.		
At the Botanical Laboratory.		
Prof. Ward. Elementary Botany, with practical work. Tu. Th. S. 10. Oct. 18. £3. 3*s.* (Microscope 5*s.*)	Elementary Botany, with practical work. Tu. Th. S. 10. Jan. . £3. 3*s.* (Microscope 5*s.*)	Elementary Botany, with practical work. Tu. Th. S. 10. Ap. . £2. 12*s.* 6*d.* (Microscope 5*s.*)
Fungi (Advanced). Times to be arranged. £1. 1*s.*		Systematic Botany (Phanerogams). Practical work only. M. W. F. 10. Ap. . £2. 2*s.*
Mr Darwin. Physiology of Plants (Advanced). M. F. 12; with practical work, F. 2. Oct. 21. £2. 2*s.*	Physiology of Plants (Advanced). M. Tu. 12. Jan. .	Physiology of Plants (Advanced). Practical work only. Tu. F. 2. Ap. . £2. 2*s.*
Mr Seward. Advanced Course (Gymnosperms, recent and extinct), with practical work. M. W. F. 9. Oct. 17. £2. 2*s.** (Microscope 5*s.*)	Advanced Course (Gymnosperms, continued), with practical work. M. W. F. 9. Jan. . £2. 2*s.** (Microscope 5*s.*)	
Anatomy of Plants (Angiosperms). Tu. Th. 9. Oct. 18. £2. 2*s.**	Elementary Biology (see below)	
Mr Blackman. Advanced Course (Algæ), W. Th. 12; with practical work, Th. 2. Oct. 18. £1. 11*s.* 6*d.* (Microscope 5*s.*)	Advanced Course (Algæ, continued, and Bryophyta), W. Th. 12; with practical work, Th. 2. Jan. . £1. 11*s.* 6*d.* (Microscope 5*s.*)	
Mr Hill and Mr Gregory.	Cytology and Histology of Plants, with practical work. Times to be arranged (one day a week). £1. 1*s.* (Microscope 5*s.*)	
Mr Biffen. *N. M.* Fungoid Diseases of Plants (for Agricultural Students). M. W. F. 10. Oct. 17. Practical work, 11. £1. 1*s.*		Botany for Agricultural Students, with practical work. M. 10. May . £1. 1*s.*

Lectures and practicals offered in Botany in 1904–05 (from the *Cambridge University Reporter*)

The Teaching Laboratory after modernization in 1998 (photo by Roger Leigh)

had been the Museum, and the Museum was thinned out, and the remaining exhibition cases transferred to the corridor on the first floor. A new teaching lab for Part II was fitted up on the ground floor of the western extension in what had been the Reading Room, and an opening was made from the Library (formerly Herbarium) to the Part II Lecture Theatre and Laboratory. The laboratories and many research rooms were equipped with fine benches and glass-fronted cupboards of iroko (*Milicia excelsa*). In the early 1960s a substantial set of new rooms was built in the eastern part of the roof. In 1998 a new reception area was built on the ground floor, a new lift was installed, the corridor on the first floor was refurbished, and the Teaching Laboratory on the second floor was modernized and converted partly into research rooms. Also the rooms on the mezzanine floor of the western extension were converted into modern research laboratories. In 2000 the old Store was converted into a new laboratory for Ecology, and a new smaller Store was built on the ground floor. EAS

Plant Systematics

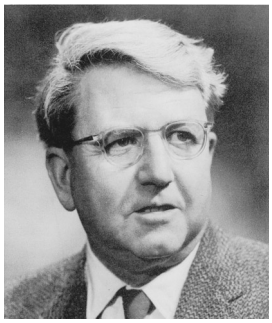
'Systematics' and 'taxonomy' are sometimes used as synonyms. If a distinction is to be made, it is that systematics is concerned with the identification, naming and classification of organisms, and taxonomy with theoretical or philosophical aspects of classification. In 1890–1920 systematic botany was kept going in Cambridge by some characterful individuals. JC Willis lectured in Cambridge 1892–94. After serving as Botanic Garden Director at Peradeniya in the then Ceylon (1896–1911), and later at Rio de Janeiro (1911–14), he retired to Cambridge with sight in only one eye. A guest lecturer in the Botany School 1920–40, he is remembered for his *Dictionary of Flowering Plants and Ferns* which ran to eight editions (1896–1986) and his controversial views on speciation in the book *Age and Area* (1922). AW Hill, on the staff 1899–1907, lecturing on cytology and histology, was destined to be Director of Kew (1922–1935) and knighted. Two pioneer ecologists served as Assistant Curator of the Herbarium: RH Yapp (1900–03, see p. 22) and CE Moss (1908–16). Moss cooperated with the local botanical artist EW Hunnybun on the grandiose but unfinished *Cambridge British Flora* (1914–20). There were also the amateur botanists. The Department welcomed 'common people' (to use a significant phrase of Henslow's!) to learn and contribute their knowledge of vascular plant systematics.

The appointment in 1921 of Humphrey Gilbert-Carter as Curator of the Herbarium and first ever Scientific Director of the Botanic Garden was to have profound consequences. All the main systematic projects of the past 80 years in which Cambridge botanists have played a significant role can be traced to Gilbert-Carter's pupils. These have included the *Flora of the British Isles* (1952, written by AR Clapham, TG Tutin and EF Warburg, only recently superseded), *Flora Europaea* (1964–92, the great five-volume work involving cooperation across the whole of the continent, edited by TG Tutin, NA Burges, VH Heywood, DH Valentine, SM Walters, and others) and the *European Garden Flora* (1984–2002, six volumes, edited by SM Walters and others). Two works of importance as yet only partly published (or about to be published) and also associated with the Herbarium are the five-volume *Flora of Great Britain and Ireland* (Vol. 5, 1996) by Peter Sell (Assistant Curator 1973–97) and Gina Murrell (current Assistant Curator), and the world monograph of the genus *Tilia* (lime) by Donald Pigott.

Parallel with the influence of Gilbert-Carter in the 1930s was that of the much younger PW Richards, known for his pioneering studies in the ecology of tropical rain forests (see p. 23). He was also a world figure in bryology, the study of mosses and their relatives, and in 1938 began a tradition of week-end excursions to a wide range of local sites, which was continued by Harold Whitehouse – to whom bryology was an important hobby, though his professional expertise was in genetics (see p. 21). As Richards left Cambridge (1949), another dominant

H Gilbert-Carter
(drawn by John Hookham)

AR Clapham



TG Tutin

EF Warburg
(permission from BSBI)

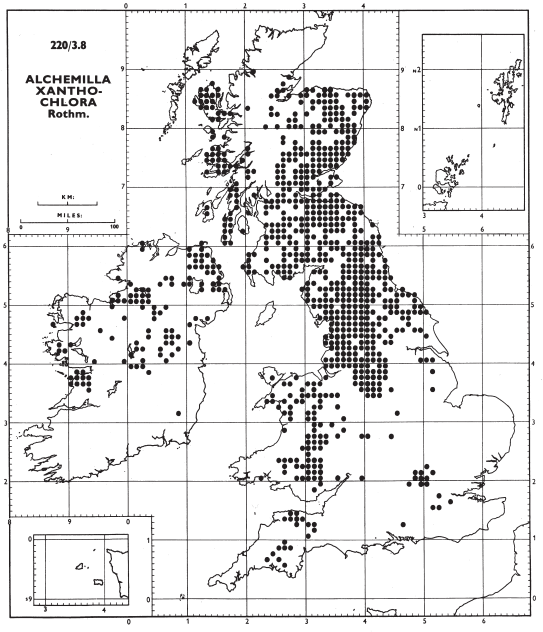
figure in tropical botany arrived: EJH Corner, noted for his highly original contributions on the morphology of flowering plants (p. 13), and his brilliant work on the taxonomy of fungi (p. 14). He was also the world authority on the family Moraceae, and especially on figs (*Ficus* with some 800 species). Corner was awarded numerous distinctions, including the Darwin Medal from the Royal Society (1960), the first Japanese International Prize for Biology (1985) and the first de Bary Medal of the International Mycological Association (1996).

In the fifty years after World War II the combination of Corner, Walters, Sell and Peter Yeo (Taxonomist at the Botanic Garden) produced over 15000 pages of text, and described over 1000 new taxa.

During World War II Professor EG Pringsheim brought his invaluable Culture Collection of Algae and Protozoa from Prague to the Department. Eric George was Curator from 1950 to 1969, and then moved with it to purpose-built accommodation off Storeys Way in NW Cambridge when it came under the care of the Natural Environment Research Council.

In the 1950s to 1970s Cambridge was one of the major centres in Britain for research on 'experimental taxonomy', which had developed elsewhere in the 1930s. It involves the growth under standardized conditions of various populations within a species in order to separate the effects of genotype and environment on plant form. Max Walters and David Briggs (University Demonstrator 1961–64 and Curator of the Herbarium 1974–2001) had a considerable series of research students working in this field, and together they wrote *Plant Variation and Evolution*, which ran to three editions (1969–97).

Traditionally, systematic botany has gone hand in hand with the recording of the distributions of species (chorology), a tradition pioneered in Cambridge by John Ray, whose famous *Cambridge Catalogue* published in 1660 was the first of a great series of county Floras which use both professional and amateur knowledge. The tradition, formalized in the nineteenth century by the Botanical Society of the British Isles (BSBI), came to fruition in Cambridge with the publication in 1962 of the *Atlas of the British Flora*. This volume introduced the 'dot maps' showing occurrence in 10-km squares, since adopted for various groups of animals as well as plants, and copied across the world. It records the results of a unique project involving hundreds of amateur and professional botanists, which was launched in 1953 and housed in the building at 1 Brookside then owned by the Botanic Garden. Max Walters, Curator of the Herbarium 1948–73, was part-time Director, and Frank Perring the full-time organizer. In 1968 Perring and Sell produced a *Supplement* for 'critical' species. In 2002 the *New Atlas of the British and Irish Flora*, accompanied by a CD carrying all the detailed records, was published; the senior author was another Cambridge-trained botanist, Chris Preston.



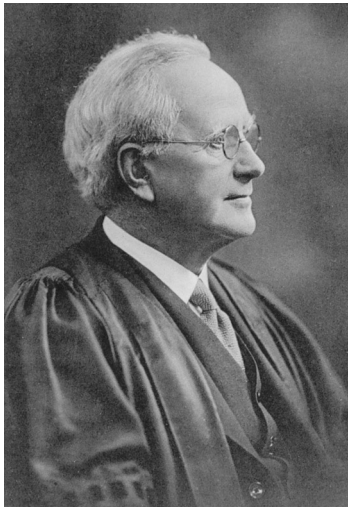
Distribution of *Alchemilla xanthochlora* (from the *Critical Supplement* 1968, with permission of the BSBI)

Inextricably linked with the work on systematics (and ecology) have been the efforts of several members of the Department to get local nature conservation launched. Early efforts were concentrated on Wicken Fen, and involved Yapp, Tansley, and Godwin as well as various zoologists. In the 1950s and 1960s when County Naturalists' Trusts were being founded across the country, Frank Perring and Max Walters took a leading part in the formation of that for Cambridgeshire. At the same time EJH Corner was active in the wet tropics, and was notably successful in helping to get the Mount Kinabalu National Park set up. SMW

Morphology

Morphology, broadly defined, was a major pre-occupation of botanists in the 19th century and the first half of the 20th. It involved equally the study of present-day plants and that of fossils, and both external form (morphology in the strict sense) and internal structure (anatomy). Much emphasis was placed on the minute details of the reproductive stages, which it had become possible to study – especially in Germany, where great improvements had been made in the compound microscope. In 1851 Hofmeister discovered the alternation of generations. This new morphology was a major attraction of German botany, parallelling the new physiology (see p. 2).

By 1904 the leading practitioner in Cambridge was AC Seward, who had graduated in 1886 in geology and botany, and then worked with WC Williamson in Manchester. Made a Lecturer in 1890, he became Professor in 1906 after the death of Marshall Ward. He went on to be Master of Downing College (1915–36) and Vice-Chancellor (1924–26) and was knighted in 1936. He was a prolific writer, describing and interpreting fossils from many different periods and places. He was less interested in classical morphology than in the evidence provided by the fossil record for past changes in climate and even continental drift. Seward's research stimulated his pupil Birbal Sahni to use his own funds to establish the Institute of Palaeobotany in Lucknow, where many important new fossils were described. Sahni was elected FRS and was twice President of the Indian National Academy of Sciences. Seward's enthusiasm for present-day plants inspired many students. One of them, RE Holttum, on the staff 1920–22, became the leading European expert of his generation on ferns. W Stiles, later distinguished for his research work elsewhere as a physiologist, began his career studying the affinities of certain conifers. HHW Pearson, a former pupil, made key discoveries about the reproduction of the giant two-leaved desert plant *Welwitschia*.



Sir Albert Seward

In 1907 Seward made the remarkable AG Tansley a Lecturer. A Cambridge graduate, he had been for nine years assistant to Professor FW Oliver (also a Cambridge graduate) at University College London, working equally in plant ecology (see p. 22) and in morphology (the anatomy of complex mosses and the reproductive parts of fossil gymnosperms). In 1902 he founded the *New Phytologist*, serving as editor and publisher until 1931; this journal carried much of the livelier work on morphology.

In the period 1910–1930 H Hamshaw Thomas, a student of EAN Arber in the Sedgwick Museum and of Seward, paved the way for a more modern approach to palaeobotany. He collected fossils in the field himself, and when examining compression fossils began to use advanced techniques that had been pioneered in Scandinavia. He discovered in Yorkshire a major new group of fossil seed plants, the Caytoniales. His highly controversial 'new morphology' (*Proceedings of the Linnean Society* 1933) was not accepted, but he contributed to the overthrow of the older, inadequate theory.

TM Harris, on the staff 1927–33, worked independently of Hamshaw Thomas and raised the technical approaches to fossils to a wholly new standard. After World War II no research on fossils was done in the department for a long time, but up until his retirement in 1982 Kenneth Sporne taught absolutely up-to-date courses on the morphology of fossils, and his text-books on pteridophytes and gymnosperms were used worldwide. The work of Sporne's student Dianne Edwards on the earliest land plants was begun in Cambridge in 1965; she has subsequently

transformed our understanding of them, particularly their vascular systems.

Three people in the department, during the years 1904–1974, took highly individualistic approaches to plant morphology. Edith Saunders started from her work on genetics (see p. 20) when formulating her now forgotten 'leaf-skin' theory of the structure of the stem, and 'polymorphism' theory of the ovary.

Agnes Arber (née Robertson) graduated from Newnham College in 1902. She began research in the private laboratory (in Reigate) of another remarkable woman botanist, Ethel Sargant. Her first book was on *Herbals* (1912), a topic suggested to her by Seward, and it made much use of the invaluable collection of volumes then in the Botany Library. Later she wrote brilliant, highly influential monographs on *Water Plants* (1920), *Monocotyledons* (1925) and *Gramineae* (1934). She was not given a post in the Department, and worked at home, but was regarded as part of the Cambridge botanical community (noted as 'adventive' in a key to personalities in the Department in the *Tea Phytologist* for 1934). Only the third woman to be elected FRS (1946), she was always conscious of the philosophical background to her work, and in later years she wrote explicitly about this issue (*The Mind and the Eye*, 1954; *The Manifold and the One*, 1957).

Godfrey Argent

Agnes Arber

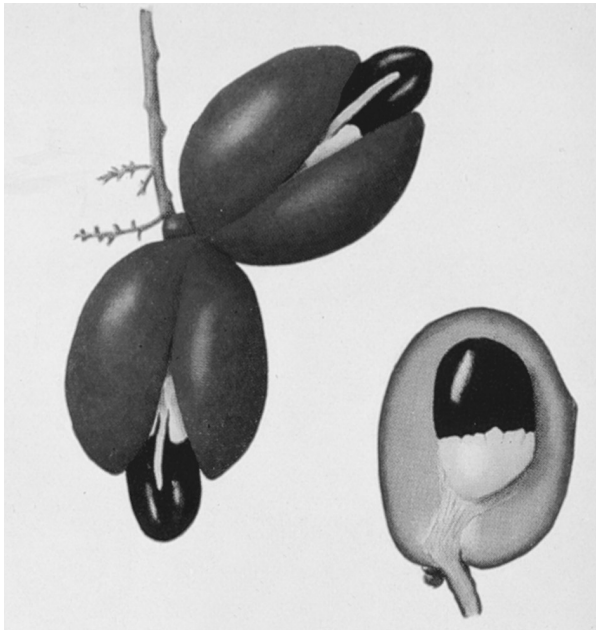
Godfrey Argent

EJH Corner

EJH Corner graduated in 1926. On his return from 20 years in the tropics, he introduced his Durian Theory for the origin of flowering plants (*Annals of Botany* 1949). Through his writings (especially *The Life of Plants*, 1964) and his lectures he inspired countless students to be enthusiastic about the theory, but modern research does not support it. Nevertheless the associated ideas of 'transference of function' between parts of plants during evolution, and 'Corner's rules' relating the sizes of plant parts, have stood the test of time. After retirement he produced his highly original two-volume treatise *Seeds of Dicotyledons* (1976).

Kenneth Sporne's pioneering statistical analysis of the correlations between many characteristics of plants, both vegetative and reproductive, as an approach to forecasting which were found in the most primitive flowering plants (*New Phytologist* 1949) has its resonance in modern-day 'cladistic' approaches.

Lectures on the morphology of a wide variety of plants, including fossils, treated from a physiological and ecological point of view, were given by Peter Grubb up to 1987 but then ceased. Morphology is now treated in the context of development (p. 19). PJG

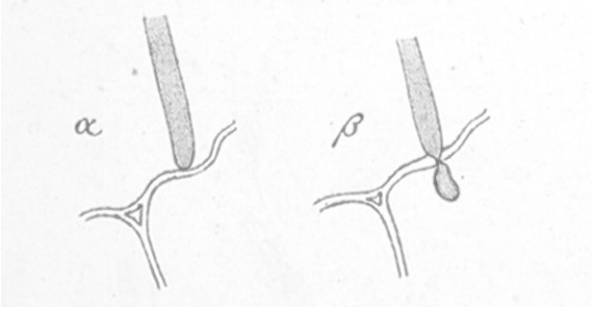


Black seed with yellow aril in red capsule of the tropical vine *Cnestis palata*, thought by Corner to be like the primitive seed (from The Life of Plants, Weidenfield & Nicholson)

Microbiology and Plant Pathology

H Marshall Ward started the tradition of phytopathology in the Department, and in particular the idea that an initiate should prove himself through a spell in some far country. He was in touch with Anton de Bary in Strasburg (p. 3), and he did superb work in 1880–81 in what was then Ceylon, proving that the rust fungus *Hemileia vastatrix* was the causal agent of the leaf-fall disease then ravaging the coffee plantations (see p. 3). Back in Britain Marshall Ward conducted an amazing number of seminal studies on parasitic, saprotrophic and mutualistic fungi. He was the first to show the extremely narrow infection thread by which *Botrytis* penetrates an epidermal wall, and one of the first to recognize 'adapted races' within one rust fungus species affecting different hosts. He also worked with bacteria, showing that their growth in culture was exponential, and that the wave band of light lethal to them was the ultra-violet.

FT Brooks graduated in 1905 and was made a Demonstrator. One year later, as a result of Marshall Ward's death, he became responsible at the age of 24 for all the teaching and research in microbiology and plant pathology. In 1913–14 he was seconded to the then Federated Malay States to study fungal diseases of rubber. He and W Brown at Imperial College London came to dominate British research on plant diseases in the first four decades of the century, and he was Professor 1936–48. He was particularly concerned with the diseases of fruit trees in orchards, especially silver leaf. He had no children, and left most of his estate to the Department for the support of research. For over half a century the Brooks Fund has proved an absolutely invaluable resource.



Infection thread of *Botrytis* passing through an epidermal wall of a scale from a lily bulb in a mere ten minutes (*Annals of Botany* 1889)

WJ Dowson, who had been an undergraduate student of Brooks and then worked on fungal diseases in Kenya and Tasmania, was on the staff from 1932 to 1952. Back in Cambridge he pioneered the study of bacterial diseases of plants. His classification of the bacteria involved is still used.

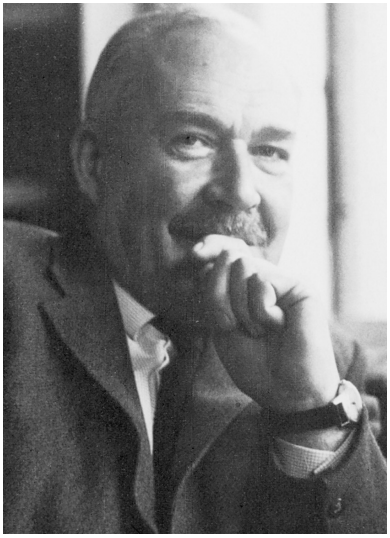
EJH Corner, already mentioned on pp. 11 and 13, began a PhD under Brooks on what he termed a 'dreary subject of parasitism of mildews', and worked instead on the development of ascocarps. Later he made fundamentally important advances in our understanding of fruit-body formation in Basidiomycota, based on the kinds of hyphae involved. In a prodigious series of papers he monographed various difficult groups of tropical fungi.

Denis Garrett, who had graduated from Cambridge, spent the years 1929–33 at the Waite Institute in Adelaide, South Australia, but learnt what he called the 'art of scientific investigation' while under W Brown at Imperial College London 1934–36. At Rothamsted 1936–48 and Cambridge 1949–73 he studied chiefly soil-borne diseases, the topic on which he had started in Adelaide. He was a pioneer in bringing an essentially ecological approach to bear on the microbial life in the soil, and he had an ability to extract from complex systems simple concepts that could be approached experimentally. His techniques were simple too; he was one of the last 'string and sealing wax' scientists. Nevertheless his ideas had a profound influence worldwide on researchers in plant pathology. He worked particularly with *Gaeumannomyces* (*Ophiobolus*) *graminis*, the fungus that causes 'take-all', a major disease of cereals.

Noel Robertson graduated from Edinburgh, worked in the then Gold Coast on viral shoot disease of cocoa, and was a member of staff 1949–59, before holding Professorships in Hull and Edinburgh. While in Cambridge he made seminal studies on parasexual recombination in *Fusarium oxysporum*, and on the processes of hyphal growth and branching.

Godfrey Argent

FT Brooks



Bertl Gaye

Percy Brian

Denis Garrett

Percy Brian, who graduated from Cambridge in 1931, and was Professor and Head of Department from 1968 to 1977, worked primarily on fungi and actinomycetes, despite his distinguished contribution to plant physiology (see p. 19). While at the Jealott's Hill and Akers Research Laboratories of Imperial Chemical Industries Ltd in 1936–63, he and his colleagues were responsible for the discovery of many different antibiotics, and for establishing their role in the soil microbial system. Of especial importance was his work on griseofulvin, used to treat mycoses of humans and domestic animals. By 1980 one million patients had been treated with it, and the world consumption was worth 25 million pounds per year.

John Rishbeth was a Brooks student in 1946–49, worked in the West Indies on *Fusarium* wilt of banana, and then returned for the period 1953–84. He succeeded Dowson in running courses on bacterial diseases, but did research on fungal diseases, especially those of trees. He is particularly known for his development of one of the very few effective kinds of biological control: the application of spores of the essentially harmless fungus *Peniophora gigantea* to cut stumps of conifers in plantations. It is superior as a competitor to *Heterobasidion* (*Fomes*) *annosum* and prevents colonization by that potentially devastating parasite. Adoption of his ideas has made a hugely important contribution to the nation's timber production.

Harry Hudson, a Sheffield graduate, joined the Department after spells in Oxford and Jamaica, and was an outstanding teacher of mycology (1960–93). His research substantially increased our understanding of fungal successions on plant parts, especially leaves.

David Ingram, who had worked with Noel Robertson in Hull and Percy Brian in Glasgow, joined the staff in 1974, and left in 1990 to become Regius Keeper of the Royal Botanic Garden in Edinburgh. He pushed forward the physiological and genetical study of biotrophic plant pathogens. The appointments of Keith Johnstone in 1984 and John Carr in 1993 took this kind of work to the molecular level.

Chris Gilligan joined the Department from Applied Biology when that subject closed down in 1989, and quickly built up a large research group dealing mainly with mathematical modelling of epidemiological problems, and was made Professor of Mathematical Biology in 2000. His work on the dynamics of disease at different scales has had a huge international impact. PJG

Physiology

The first person in the world to use the experimental method in plant physiology was Stephen Hales, Fellow of Corpus Christi College 1703–09 and Vicar of Teddington 1709–1761. In his book *Vegetable Staticks* (1727) he published pioneering studies on the movement of water and mineral nutrients through plants. His example was not followed for many years.

Teaching and research in plant physiology in Cambridge (and indeed in Britain) really took off in the 1870s and 1880s under S H Vines, Francis Darwin and Marshall Ward, all of whom had studied under Julius von Sachs in Würzburg. At first Vines was all-important because of his inspired teaching. FO Bower, his former pupil, noted that Vines had 'an acquisitive and critical rather than a constructive mind'. Although Vines did significant work on proteolytic enzymes, he was not a great experimentalist. Francis Darwin was an outstanding teacher in a different way. According to *The Times* obituary he was not an eloquent or showy lecturer, but he was noted for his modesty, making his audience feel like fellow-students rather than beginners asking stupid questions. His handbook *Practical Physiology of Plants* (1894), written with one of his first pupils (EH Acton), was widely used. He did superb research on the movements of 'sensitive' plants and the behaviour of stomata. Marshall Ward was also a fine experimentalist. Although he published an English translation of Sachs' lectures on the physiology of plants, his own research concerned fungi and bacteria (see p. 20).

FF Blackman
(drawn by FA de Biden Footner)

When the new building was opened in 1904, FF Blackman was the shining new light in plant physiology – in that year he was appointed a Reader in succession to Francis Darwin. He had graduated in Cambridge in 1891 and been made a Junior Demonstrator immediately, then Lecturer in 1897. One of his first triumphs was to establish by experiment that uptake of CO_2 by the leaf occurs almost entirely through the stomata. GE Briggs recorded that Blackman's lectures 'inspired reverence'.

Blackman was destined to have great influence and many research students, several of whom distinguished themselves elsewhere in later years, either as physiologists as in the case of TA Bennet-Clark, WO James, F Kidd, D Thoday and M Thomas, or in other aspects of plant science as with AR Clapham in ecology and taxonomy, and JS Turner in ecology and physiology. No other figure had so great an impact on the development of plant physiology in Britain in the period 1900–1930.

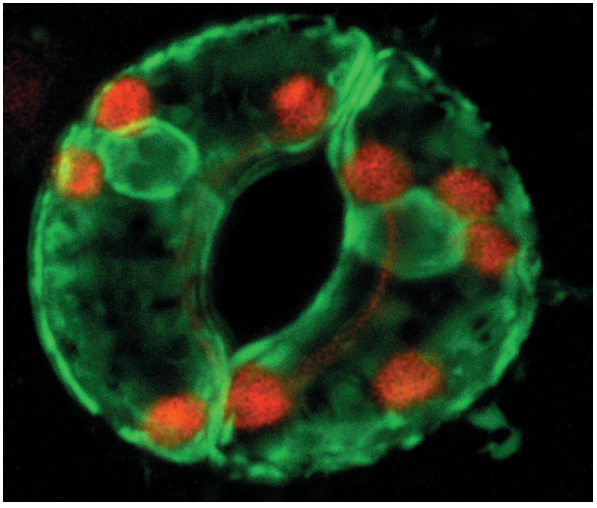
In 1904 Blackman was about to produce his well-known paper 'Optima and limiting factors' in the *Annals of Botany*. Today, apart from the concept of limiting factors, he is best known for his thesis that photosynthesis must involve separate light and dark reactions. In fact, for fifty years he and his successors and their students investigated rates of photosynthesis in relation to physical factors, and rates of respiration in relation to tissue age, the concentrations of various sugars, and other chemical compounds (notably phosphates) that might control rates. The approaches used to probe the biochemical side were mostly indirect, and the advances made seem modest now.

It was left to Robert ('Robin') Hill in the Biochemistry Department to develop a method to separate chloroplasts from the rest of the cell contents, to demonstrate conclusively the separation of light and dark reactions, and to pave the way for much modern biochemical work on photosynthesis. Hill had taken Blackman's lectures in Part I of the Tripos, but read Chemistry in Part II. He taught practical plant biochemistry to Part II Botany students from 1937 to 1960.

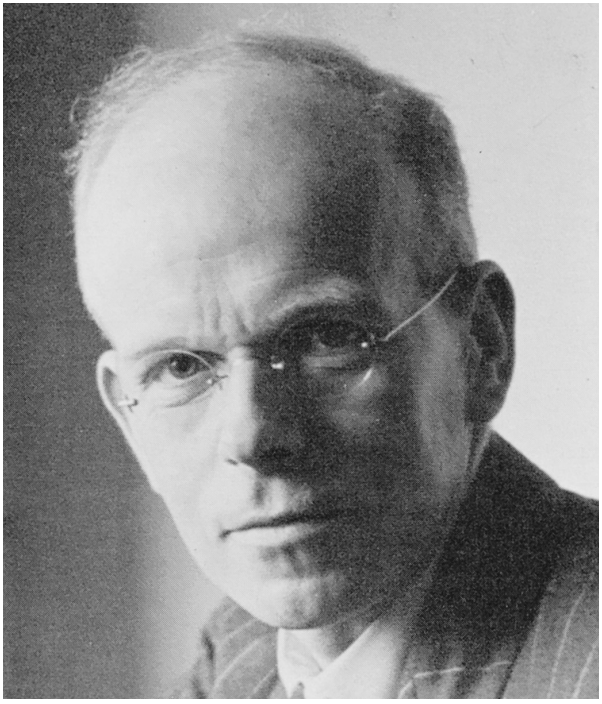
CS Hanes's pioneering studies in the Cambridge Low Temperature Research Station in the late 1930s on the structure and metabolism of starch had their origins in his doctoral research under Blackman in the 1920s. He introduced the idea

of a biological polymer (in this case amylose) having a helical structure, and he discovered plant phosphorylase – now known to be important in the breakdown of starch, though it seemed at the time that it might effect synthesis. Hanes returned to the Department as a Reader 1947–50.

GE Briggs, a Blackman student appointed to a Demonstratorship in 1920 and to the first personal chair in the Department in 1946, introduced an explicitly mathematical approach, and was remarkable for making significant advances on several different fronts. Briggs and JBS Haldane developed a modification of the Michaelis-Menten hypothesis that was rapidly accepted. With F Kidd and C West, and in parallel with FG Gregory at Imperial College London, Briggs laid the foundations for modern 'growth analysis', breaking down relative growth rate into 'unit leaf rate' and 'leaf area ratio'. His theoretical analysis of the uptake of CO_2 in photosynthesis laid the foundations for Rackham's experimental work in the 1960s (see p. 23). His separation of 'free space' and 'non-free space' in a plant tissue prepared the way for a refined understanding of multi-phase ion uptake. For some years he included the cytoplasm in the 'free space', open to diffusion from outside, but fortunately his student



Guard cells of a stoma, the subject of research by staff members from Francis Darwin onward, here with green fluorescent protein on the endoplasmic reticulum, and red fluorescence from the chloroplasts (photo by Andrew Baker & Alex Webb)



GE Briggs (self portrait)

Michael Pitman (on the staff 1958–62) developed flux analysis and established the role of the plasma membrane in controlling ion uptake. In retirement Briggs wrote the characteristically dense but insightful *Movement of Water in Plants* (1967).

Like Blackman, Briggs had many students who later achieved distinction, most notably Sir Rutherford ('Bob') Robertson, who did seminal work on the quantitative relationship between the rates of respiration and ion uptake, became the President of the Australian Academy of Science, and encouraged the development of an exceptionally gifted generation of plant physiologists there.

Teaching alongside Briggs from 1931 was EJ Maskell, who had just come back from the Cotton Research Laboratory in Trinidad and his highly regarded research there on the mechanism of phloem transport. In Cambridge he continued the Blackman tradition of studying plant respiration. So did his successor from 1952, J Barker, who explored particularly

the mechanisms of anaerobic respiration in plants and the effects of unnaturally high oxygen concentrations.

Apart from the contributions of Briggs and his associates in the field of ion uptake, the period 1940–60 was one of modest advance in plant physiology in the Botany School. Under Barker and Charles Whittingham (on the staff 1952–58) the techniques newly available for research on plant metabolism were adopted. In the early 1960s Martin Canny (on the staff 1955–57 and 1960–64) did important work on translocation. The first electron microscope was installed in 1963 by Patrick Echlin (on the staff 1963–99); his books on technique (especially *Scanning Electron Microscopy and X-ray Microanalysis*, 1981 and later editions, written with JI Goldstein *et al.*) were used by thousands.

Major advances in understanding and a strong new Cambridge influence nationally and internationally came when MacRobbie succeeded Briggs and ap Rees succeeded Barker. They attracted large numbers of very able research students and post-docs, who went on to occupy leading roles in Britain and abroad.

In 1962 Enid MacRobbie, who had been a student of Jack Dainty at Edinburgh and worked as an independent scientist with Briggs, succeeded him as the leader of research on the ionic relations of plant cells. Research was done particularly on giant algal cells (Characeae) and on stomata, and routinely involved electrophysiological work as well as flux studies with radio-active tracers. It was ultimately concerned with the control of ion fluxes. Her work was characterized by a combination of mathematical rigour and an effective 'feel' for how plant cells work, as seen in her early recognition of the role of vacuolar fluxes in controlling the ionic relations of cells, and her use of systems in which membrane-bound fractions frequently fragment and coalesce (as with the vacuole of the guard cell).

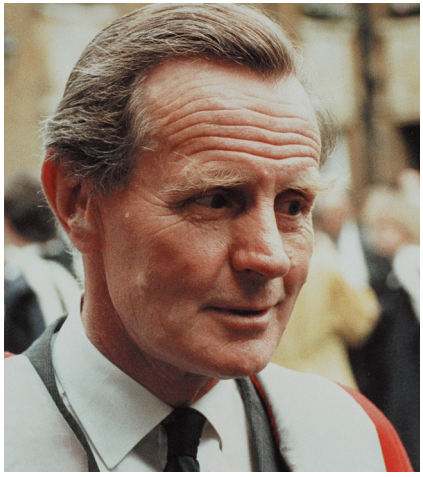
Just three of MacRobbie's outstanding associates can be mentioned here. Her student John Raven, on the staff 1968–71, worked on ion uptake and utilization of bicarbonate in the alga *Hydrodictyon*, and then on pH-regulation in the cytoplasm. He has subsequently become distinguished for a very wide range of studies not only within physiology but also at the interfaces with ecology and evolution.

Roger Leigh, who was an independent researcher with MacRobbie in 1976–79, returned as Head of Department in 1998. He has made pioneering studies of the role of plant vacuoles with particular emphasis on the regulation of ion concentrations in the vacuole and cytosol. Recent research has concerned the variation in vacuolar functions in different cell types within one organ.

Mark Tester, a MacRobbie student and on the staff 1992–2003, linked physiology and ecology, aiming to understand at the molecular level the reasons behind the distributions of plants in relation to soil types. He used random gene activation in specific cell types to understand the control of potentially damaging salt uptake in *Arabidopsis* and rice.

Tom ap Rees, who had trained under JL Harley at Oxford, and worked in the United States and Australia, succeeded Barker in 1964. He was made Professor of Botany in 1991, and tragically killed in a road accident in 1996. By the mid–1960s most of the major synthetic pathways had been established, and it had become possible to apply a new level of sophistication to

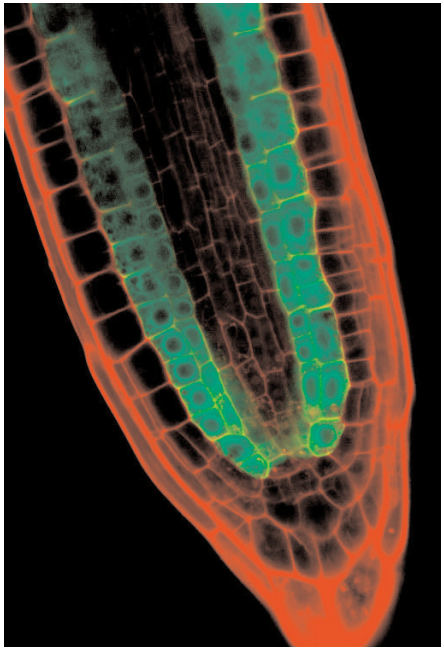
Enid MacRobbie



Tom ap Rees

studies on the ways in which the fluxes of carbon through various pathways were controlled. Tom ap Rees pressed for new standards of rigour in the design of experiments and interpretation of results. He and his students worked particularly on the synthesis of starch (especially in intact isolated amyloplasts), gluconeogenesis in fatty seeds, anaerobiosis, and thermogenesis in inflorescences of Araceae.

Fortunately for the Department, molecular biology (the study of physiological processes at the level of individual genes and proteins) was established at a relatively early stage by the appointment of John Gray to the staff in 1976. His research group quickly became the largest, and he was given a personal chair in 1996. Major advances were soon made, especially in our understanding of the assembly of the chloroplast, under dual control by the DNA in that organelle and in the nucleus. Also many able students, now making key advances in quite different fields in plant biochemistry, were given their start under John Gray. Among them Alison Smith, on the staff from 1984 and a Reader from 2001, has studied the control of synthesis of tetrapyrroles and the pathway of synthesis of pantothenate (vitamin B5), gaining great advantage from co-operation with an organic chemist and a structural biologist.



Optical section of a root apex: the GFP (linked to the endoplasmic reticulum) is confined to endodermis and cortex; the red fluorescence in the walls is from propidium iodide (photo by Jim Haseloff)

The manipulation of genes and use of *Arabidopsis thaliana* have revolutionized research in the Department on metabolism and ion uptake as well as that on plant pathology and plant development.

Up to the 1950s some of the Cambridge morphologists, notably Arber and Corner, emphasized the value and fascination of studying the development of plant organs, especially leaves and flowers, but the physiologists did not enter the field. Indeed they showed disdain for the often rather naïve early work suggesting that differences in the concentration of a single growth substrance, indolylacetic acid, controlled so many developmental processes. The link between the Department and the physiology of plant development was forged by Percy Brian. Soon after he became Head in 1968, he established the Agricultural Research Council's Unit of Developmental Botany off the Huntingdon Road. There important work was done on the impacts of ethylene and its interactions with other plant hormones, on the development of tumours, and on fungal development in relation to infection of plants by biotrophic fungi. Earlier, in the late 1950s, when Brian was working in the Aker laboratories of ICI (see p. 15), he had made a huge contribution through his rediscovery of the gibberellins, and rapid demonstration of their diversity and the wide range of activities under their control.

The next important phase in the study of plant development in the Department came when David Hanke, trained in plant biochemistry under DH Northcote, was appointed in 1971. He has focussed on cytokinins and inositol and introduced immunological methods.

In 1999 Jim Haseloff joined the Department, having worked in Adelaide, Harvard and the MRC Laboratory of Molecular Biology in Cambridge. He had already succeeded in adapting the green fluorescent protein (GFP) from a jellyfish for expression in plants. He used the GFP as a non-invasive probe for plant gene expression, and generated many transgenic lines of *Arabidopsis* that provide unique markers for cell fate during development. GFP can be visualized at very high resolution in cells using confocal laser scanning fluorescence microscopy. It can be fused to other proteins to 'paint' particular processes in transgenic plants. Physiologists all over the world now use this approach routinely. PJG

Genetics

All educated people know that scientists in Cambridge made many of the most important discoveries in genetics in the second half of the 20th century. What is less well known is that scientists in Cambridge in the 1890s were on the verge of elucidating the principles of heredity, before the 'rediscovery' of Mendel's Laws in 1900. Moreover one of the leading players was a woman working on the genetics of plants. Edith Saunders was one of the original collaborators with W. Bateson, who was to become the first Director of the John Innes Horticultural Institute. She graduated at Newnham College with First Class Honours in 1888, at a time when women were still not admitted fully to University courses.

Working with such contrasting features as hairiness and smoothness, Saunders found in experiments at the Botanic Garden in the 1890s what we now call dominant and recessive characters. When Mendel's work was brought to light in 1900 her work with both plants and animals was given fresh impetus. In 1902, together with Bateson, she reviewed the extent to which the available data on inheritance agreed with Mendel's principles (*Reports of the Evolution Committee of the Royal Society*). In this paper several basic terms used routinely in genetics today were introduced: allele (as allelomorph), heterozygous and homozygous, and P, F_1 and F_2 generations. In 1905, using data from an experiment with sweet pea *Lathyrus odoratus*, she published with Bateson and RC Punnett the first evidence for partial linkage. Although they favoured an obscure 'reduplication' model as the explanation, the phenomenon ultimately led to the recognition of the linear arrangement of genes on chromosomes. Like her colleagues, she was initially disinclined to accept the chromosome theory of inheritance put forward by WS Sutton in 1903, and enthusiastically championed by TH Morgan. However, in 1920, after reviewing the evidence critically, she accepted the chromosomal theory before Bateson did so. She was a Fellow of Newnham College, but never became a member of staff. She ran inspiring and rigorous practical classes, and supervised research students, including EF Warburg later distinguished as a taxonomist (p. 8). Outside Cambridge her distinction was recognized by her becoming one of the first women Fellows of the Linnean Society (1905), President of the Botanical Section of the British Association in 1920 and President of the Genetical Society of Great Britain in 1936–38.

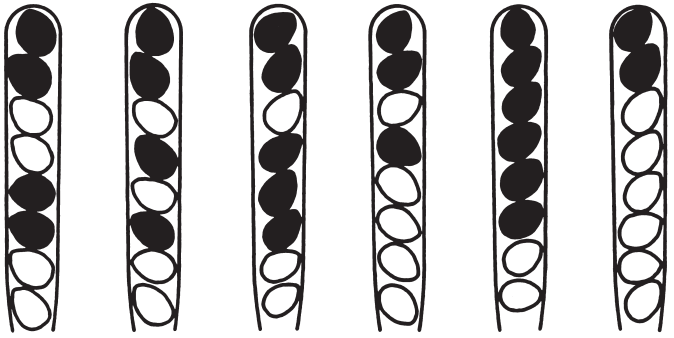
Edith Saunders

Two of the sweet pea (*Lathyrus odoratus*) genotypes used by Edith Saunders, from Bateson (1909) *Mendel's Principles of Heredity*.

The first staff member taken on to teach and do research in genetics and cytology was RP Gregory (1907–18), who was badly gassed on the Western Front in 1917 and died of pneumonia the following year. The next was DG Catcheside, who had trained first under Ruggles Gates at King's College London. He arrived in Cambridge in 1937 after a year at the California Institute of Technology, working with the now legendary group of geneticists headed by TH Morgan. According to PW Richards, the ecologist, Catcheside 'brought us into the modern world'; he established courses in genetics within Botany in both Parts I and II of the Tripos at a time when there was no equivalent genetical teaching in Zoology. Catcheside also quickly built up a group of research students, which included several who went on to be leaders in their own right – two of them Professors of Genetics at Cambridge (JM Thoday and JRS Fincham). While in Cambridge he worked particularly on the effects of ionizing radiation on chromosomes, but also began his brilliant work on fungal genetics. He left in 1952 to be the first Professor of Genetics in Australia (at Adelaide), and was later a leader in the formation of the prestigious Research School of Biological Sciences of the Australian National University in Canberra.

It was while a Catcheside student that Harold Whitehouse (on the staff 1948–84), established fungal genetics in Cambridge, using *Neurospora*. In particular he exploited the ordered array of the eight spores in the cell in which they are formed (the ascus). The order of different inherited characters such as spore colour or deficiencies in biosynthetic ability can provide critical information regarding the process of chiasma formation between chromosomes during meiosis, which is recognized in the analysis of genetic crosses as 'crossing over'. In *Nature* in 1963 Whitehouse introduced the idea that this recombination process involves the formation of 'hybrid DNA'. His exact suggestions proved not to be correct, and his distinguished former student Robin Holliday produced a more nearly correct hypothesis the next year. However, the general idea that hybrid DNA is made during chiasma formation has proved to be correct, and Whitehouse later made further important contributions to understanding the process. His masterly *Towards an Understanding of the Mechanism of Heredity* ran to three editions (1965–1973). He was also an outstanding bryologist (p. 9).

David Hopwood (Sir David since 1994), a member of staff 1957–61, initiated his life-long study of the genetics of the Actinomycetes while a Whitehouse research student, following a suggestion from Lewis Frost (on the staff 1951-55). When he began in 1954, almost nothing was known of inheritance in this group of organisms which are so important for their production of antibiotics. The genome of *Streptomyces coelicolor* has now been sequenced completely, and the functions of many of the genes determined. Hopwood has been particularly concerned with the synthesis of antibiotics and the generation of novel drugs via the engineering of *Streptomyces* genes. PJG



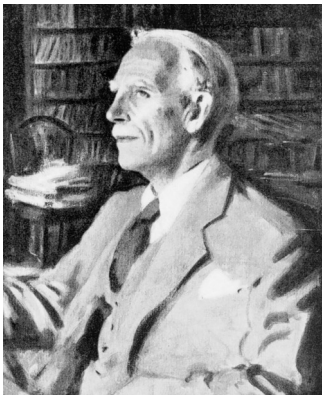
Ordered spores in asci of *Sordaria fimicola* showing evidence of segregation at different stages in meiosis, from Whitehouse (1973) *Towards an Understanding of the Mechanism of Heredity*, Edward Arnold)

DG Catcheside

Ecology

The pioneer in modern plant ecology and conservation in Cambridge was RH Yapp, who worked in the fens while Assistant Curator of the Herbarium in 1900–03, before going on to Chairs in Aberystwyth, Belfast and Birmingham.

Plant ecology really got off the ground in Cambridge when AG Tansley was appointed a Lecturer in 1907. He was a visionary. He quickly became the Chairman of the National Vegetation Committee, concerned with producing a descriptive account of all the major vegetation-types in the British Isles, and was the first President of the British Ecological Society and the only person to be elected a second time – in the Society's 25th year. Although he adopted the experimental approach to only a modest degree himself, he exhorted others to use it. He was inspired by the North American F E Clements to see 'succession' as an all-pervasive process, whereby the vegetation on all kinds of substrate were supposed to be relentlessly changing toward a 'climax', but he rejected Clements's notion that in any one area there was just a single climax type determined by the climate. As well as editing the *New Phytologist* from 1902 to 1931, he edited the *Journal of Ecology* from 1917 to 1937. His best-known publications, the paper in which he launched the concept of 'ecosystem' (*Ecology* 1936) and the two large volumes on *The British Islands and their Vegetation* (1939), came after he had moved to the Sherardian Chair at Oxford in 1927. So did his sterling work to get the Nature Conservancy founded, and his knighthood (1950). He remained influential long after his retirement from Oxford to Grantchester in 1937.



Sir Arthur Tansley (from a portrait by Wilfrid de Glehn RA, *Journal of Ecology* 1958, Blackwell)

One of his research students, AS Watt, joined the staff in 1934 after a spell in the short-lived Cambridge Forestry Department. He made pioneering studies on the factors limiting regeneration of major tree species in Britain, and on the impacts of soil on vegetation. In his 'pattern and process' paper (*Journal of Ecology* 1947) he emphasized the value of studying 'regeneration' rather than 'succession', i.e. the processes whereby individuals come and go, while the vegetation-type persists. This paper is widely regarded as one of the most important in plant ecology from the 1940s. Studies on this aspect of dynamics exploded in the second half of the 20th Century, and are now regarded as basic to any sensible approach to conservation. Watt was also among the first to stimulate research on the question as to why – in a given community-type – some species are generally abundant and others generally sparse.

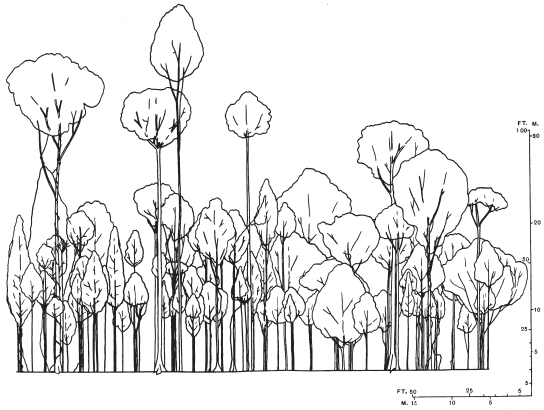
AS (Sandy) Watt (photo by William Block)

SM Wadham, on the staff 1919–26, also worked in ecology. He left to become Professor of Agriculture in the University of Melbourne, and was knighted in 1956.

Harry Godwin worked for his PhD in laboratory plant physiology under FF Blackman, but then changed to field-based studies. As a member of staff from 1923, he pioneered both critical quantitative descriptive studies and experiments to understand the factors determining the distributions of various vegetation-types at Wicken Fen. Although he was destined to make his greatest impact through Quaternary Research (p. 24), he remained active in supporting work in 'neo-ecology' and conservation. He was Professor 1960–68, and knighted in European Conservation Year (1970).

A different pioneering contribution was made by Paul Richards, on the staff 1938–49; he went on expeditions to tropical lowland rain forests in northern South America, Borneo and West Africa in a space of seven years (1929–35), and wrote a masterly comparative account of all the then-studied aspects of that vegetation-type. *The Tropical Rain Forest – An Ecological Study* was published in 1952 after Richards moved to the Chair at Bangor. It inspired students the world over.

One of Richards's colleagues on the expedition to West Africa in 1935 was Clifford Evans, who worked for his PhD under GE Briggs. On the staff 1937–79, he made his mark particularly by using a 'fish-eye' lens and a special apparatus of his own to provide the first-ever reliable estimates of the proportion of light received by understorey plants as 'sunflecks', short-lived bursts of direct radiation piercing the canopy. His book '*Quantitative Analysis of Plant Growth*' (1972) played a critical part in getting the Briggsian type of 'growth analysis' established among ecologists, who now take its value for granted.



A Richards profile diagram for tropical lowland rain forest in Borneo (*Journal of Ecology* 1936)

Evans's pupil David Coombe, on the staff 1952–89, was expert in a number of aspects of plant ecology, but suffered from illness for many years. He made pioneering contributions to the study of plant growth in relation to the forest light climate, to our understanding of the differences in relative growth rate between trees and herbs, and to the appreciation of loess as a component of British soils. He was also an early proponent of the value of studying the history of vegetation in recent centuries.

Oliver Rackham, while a student of Evans and a member of staff in 1964–68, made profoundly important studies on the factors determining the maximum photosynthetic rates of plants, demonstrating the role of the 'mesophyll resistance' and confounding the ideas of the world leaders at the time. Later – while an independent researcher – he became known for his all-encompassing studies of the history of not just woods but the landscape as a whole, and in 2002 was the first ecologist to be elected a Fellow of the British Academy. From the 1980s he expanded his research to several other countries. His *Making of the Cretan Landscape* (1996), written with archaeologist Jennifer Moody, set the highest standards for inter-disciplinary studies on vegetational history.

Donald Pigott (earlier a Godwin research student) was a Lecturer in 1960–64. Of his work in that period the most influential was that on the mechanistic basis for the failure of various species at the edges of their ranges. He was among the first to isolate the particular stages in reproduction that are especially temperature-sensitive.

Peter Grubb, another ecologist trained first as a physiologist (under GE Briggs), and a staff member 1961–2001, worked on a wide variety of problems in many different types of vegetation around the world, ranging from tropical rain forest to desert. He published in *Biological Reviews* in 1977 his idea that the coexistence of several to many species in one vegetation-type is maintained to a large extent through the different species having different requirements for regeneration (different 'regeneration niches'). Grubb's general approach to a number of problems, embodied in the motto 'a positive distrust in simplicity' has also been widely appreciated. One of Grubb's students, Edmund Tanner (on the staff from 1979), has made his mark in studies on montane and lowland rain forests of the neotropics.

Ian Woodward, a Pigott student at Lancaster, followed Evans as the Department's ecophysiologist from 1979 to 1991. His most influential Cambridge projects were on the impacts of carbon-dioxide concentration on stomatal density, and on the mathematical modelling of key properties of vegetation on a world scale, set out in his book *Climate and Plant Distribution* (1989). PJG

Quaternary Studies

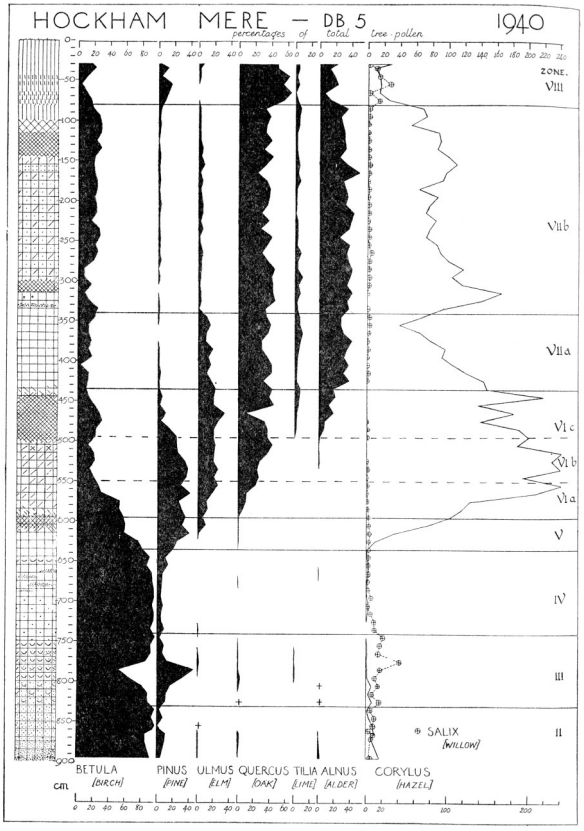
The Quaternary Period is taken to cover the last 1.8 million years, a time when many successive glacial periods caused huge changes in the world's vegetation cover. In Scandinavia in the late 19th and early 20th centuries there grew up the practice of drilling in bogs and fens to obtain cores of peat, so as to be able to follow changes in the record of pollen and macrofossils. 'Pollen diagrams' – showing changes in relative abundance of pollen types over the years – were produced.

This approach was adopted by a number of people in Britain in the 1920s, but it really took off in this country after Tansley suggested to Margaret, wife of Harry Godwin, that she should try the technique in the Fenland of Cambridgeshire. The first Godwin & Godwin paper on pollen analysis appeared in the *Geological Magazine* in 1933. Harry Godwin quickly saw the potential of the technique, especially in an inter-disciplinary context uniting ecologists with geologists and archaeologists. In 1938 he proposed the establishment of an inter-disciplinary Sub-Department of Quaternary Research, and in 1948 the idea came to fruition. It was housed in Botany.

Godwin was also very quick to see the potential of ^{14}C-dating, after its introduction by WF Libby and colleagues in 1949. By 1952 he had established a ^{14}C-dating laboratory in Cambridge, run by Eric Willis (and later by Roy Switsur), one of the first in the world. In the 1950–60s members of the Sub-Department were to provide a secure set of dates for the patterns of change that by then were becoming clear for various parts of Britain. In this period they contributed much to environmental archaeology.

Sir Harry Godwin (photo by Godfrey Argent)

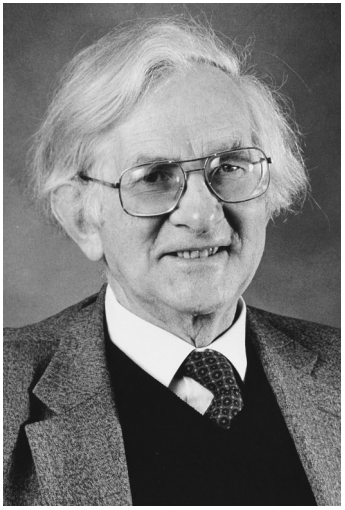
Donald Walker, a Godwin student, on the staff 1952–60, produced an especially influential paper in the *Festschrift* for Godwin (*Studies in the Vegetational History of the British Isles* 1970), collating the record of pollen and macrofossils in the peat at a great variety of sites across Britain. He was able to show that, even under fairly uniform conditions, succession could follow



Tree-pollen diagram for Hockham Mere in Breckland (*Journal of Ecology* 1951)

various pathways. Certainly there had been a relentless tendency for change from open water to reed swamp, then fen, then fen woodland and then bog, but not every stage was found at every site. That was a blow to the ecologists who thought that in any one succession each stage in a series was necessary for invasion by the next. Walker left to set up a Department in Canberra where he and his colleagues revolutionized our understanding of the complex history of tropical rain forests, long treated as unchanging 'Tertiary relicts'.

A huge step forward was taken by Richard West, another Godwin student, on the staff from 1957 and Professor of Botany 1977–91. He initiated studies of the changes that occurred during various interglacial periods of the Quaternary in Britain, i.e. times when the great ice caps receded to something like their present extent. He was able to show that although there were commonalities between the patterns of vegetational succession in the various interglacials, the patterns were distinct. This evidence was important in providing support for the 'individualistic' interpretation of vegetation proposed by HA Gleason in North America – the idea that species respond individually to environmental factors rather than as tightly knit sets of species called 'communities'. West also emphasized the fact that some plant species are repeatedly found to be slow to migrate; the implication is that we must not treat present-day distributions as necessarily being limited by physiological tolerances.



Richard West

Godwin followed his success with ^{14}C by persuading Nick Shackleton, who started as a research student in 1958, to establish a laboratory for the determination of 'palaeotemperatures', i.e. sea temperatures at various times in the past, based on the proportion of the ^{18}O isotope in the oxygen of minute fossil shells in deep-sea deposits. Sir Nicholas Shackleton, as he became in 1998, went on to revolutionize our knowledge of changes in sea temperatures, not just for the Quaternary period, but way back into the Tertiary, i.e. over more than 30 million years. His work has informed countless studies on changes in world vegetation during that time. These fundamental studies underpin much modern speculative research on what changes in world vegetation are likely to follow the current changes in world climate.

Jim Dickson, while on the staff 1965–70, pioneered the Quaternary history of bryophytes. John Birks, a West student and another notable bryologist, on the staff 1971–84, was a leader in applying numerical analysis to the interpretation of pollen diagrams. He also employed his computing skills in representing the rates of migration of various tree species after the retreat of the ice at the end of the last glacial period, and in 1983 Brian Huntley and he published *An Atlas of Past and Present Pollen Maps for Europe: 0-13000 Years Ago*.

Keith Bennett, a Birks student, joined the staff in 1985. His *Evolution and Ecology: the Pace of Life* (1997) caused a stir because it emphasized the evidence that vegetational change during the last two million years seems to have involved mostly changes in the distributions of long-persisting species rather than the evolution of new species.

The considerable contribution made by the Sub-Department under Richard West to understanding the Quaternary geology in Britain was expanded through Phil Gibbard (appointed 1984), who developed rigorous new stratigraphic and sedimentological treatments of Quaternary sequences.

In 1977 the facilities for determining ^{14}C dates and ^{18}O palaeotemperatures, which had been in temporary accommodation in Station Road, were moved to the Examination Schools building on the northern side of the New Museums site. In 1979 they were named the Godwin Laboratory. By the end of 1994 Shackleton had moved to the Department of Earth Sciences, and Gibbard to Geography. When Bennett left for a Chair in Uppsala in 1998, and Plant Sciences experienced another squeeze on posts, the distinguished tradition of Quaternary Research in the Department came to an end. The Godwin Institute for Quaternary Research is now housed partly in the Earth Sciences Department and partly in Geography. PJG

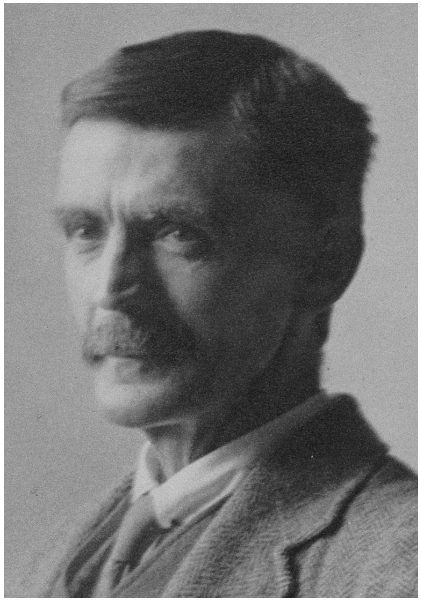
Assistant Staff

Throughout the last century the assistants have played a vital role in both teaching and research in the Department. At first the numbers were small, but after World War I they increased considerably. They then steadied in the 1930s. After World War II they increased enormously, reaching a peak of 60 in 1969. As a result of financial constraints in the last three decades the number has fallen to 42.

The Professor's Annual Report for 1895 records that the Department employed Arthur Shrubbs as 'the assistant' (annual wage £90), Thomas Elborn as the '2nd assistant' (£50.12s.0d) and an unspecified number of 'Boys' (collectively paid £36.8s.0d). The establishment paralleled that in an upper middle class home, where the butler was far above the other servants. Indeed, at that time the employees in the laboratories were generally called 'servants', and the term 'assistant' was usually confined to the academic assistants to the Professors. The staffing in Botany probably remained much the same up until World War I. Certainly Shrubbs and Elborn continued until they died in office in 1922 and 1925 respectively.

Members of the Department were active in the fledgling trade union for technical assistants in all scientific departments, founded in 1893 as The Cambridge Science Schools Employees Club, open to employees over the age of 18. After a few months the title was changed to The New Museums Club. Arthur Shrubbs of the Botany School became the first Vice-President. Fred Stoakley (of the bookbinding family) was the first President; he was a 'servant' in the Chemistry Department, where he had started as a 'boy' at the age of 12. Shrubbs, who had a similar background, gave a lecture on 'Leaves' to the Club at the end of the first year followed by a social gathering and refreshment. The Club's activities expanded in the Edwardian period, but were greatly curtailed by the outbreak of war. It was not until 1919 that formal recognition by the University through the Whitley Council began to be negotiated. Seward (Professor of Botany) was in the Chair. By November 1922, the University had accepted the aims of the New Museums Club concerning wages, conditions of service and a contributory pensions scheme. The Club was in due course replaced by the Association of Cambridge University Assistants (ACUA). Since 1976 the University has negotiated not only with ACUA but also with two national trade unions: the Association of Scientific, Technical and Managerial Staff

A Shrubbs, on the staff 1870–1922



TB Elborn ('Henry'), on the staff 1880–1925

(ASTMS, now AMICUS) and the National and Local Government Officers' Association (NALGO, now UNISON).

During the 1920s the New Museums Club mounted periodic Scientific Exhibitions in the Examination Halls, at which assistants illustrated their work. At the 7th Exhibition (in 1923) the Botany Exhibit contained six sections: Physiology, Fossil plants, Herbarium specimens from Greenland and Spitzbergen, Microscopic Anatomy, Microscopic Algae, and Mould growths. At the 8th Exhibition (in 1926) the Botany Exhibit had similar sections.

During the period 1919–25 at least nine new assistants were recruited, and five of these were senior assistants in the early 1950s: Charles Sewell (Chief Assistant, formerly in the Physiology section), Bill Stigwood (Elementary Laboratory), James Bean (Mycology and Pathology), FTN ('Henry' like his father) Elborn (Photography and the Store), and GB ('Herbert') Newham (Workshop). CB ('Steve') O'Donahue, who had started in the 1930s in Mycology, was in charge of the Office, and Roy Whybrow of a similar vintage was the senior technician in the Culture Collection of Algae and Protozoa.

Peter Barham (on the staff 1941–89 and Principal Technician 1971–89)

It is clear that by the 1930s most members of the Academic Staff had a dedicated technician, who would help with both teaching and research. In the 1950s there was a huge increase in the number of assistants, so that the number, relative to the Academic Staff, was among the highest in the University. This increase was effected by Clifford Evans who had been put in charge of the Assistant Staff by Briggs when he became Professor in 1948. Evans was also responsible for introducing women assistants to the Department. He was helped by Miss Miller, Juvenile Employment Officer of the County Education Committee, who acted as a 'scout' in local schools. Evans also ensured that a new qualification for assistants in biological laboratories (Certificate of Proficiency in Laboratory Technique) was instituted, taught partly at the Technical College (now part of Anglia Polytechnic University) and partly by senior technicians in various Departments. In addition he introduced 'day release'. Large numbers of technicians were trained for a few years in Botany before going to Departments that failed to develop such forward-looking schemes, or to the laboratories of local industry or the Civil Service. By 1957 the total number of technical, library, clerical and cleaning staff was 44, and by 1969 it was 60.

This expansion occurred during the long reign as Chief Technician (1940–71) of Charles Sewell, who was a truly benevolent autocrat. He was succeeded in a more democratic style by Peter Barham (1971–89) and Ray Hill (1989–2001). All three men gave their whole professional lives to the Department. The long periods served by so many assistants are, we believe, a sign of the happy atmosphere in the Department over the years, and the care taken over the affairs of the Assistant Staff by successive members of the Academic Staff. Another feature of which the Department may be proud is the flexible relationship between Assistant and Academic Staff. Peter Sell, who started as a boy of 14 in 1944, cycling in 15 miles from Bassingbourn every day, proved to be such a productive author in plant systematics that he was made Assistant Curator of the Herbarium in 1973 and so joined the Academic Staff. Recently Gina Murrell has made the same transition. Michael Hall, initially a technician in Quaternary Research, became a Technical Officer in 1988, and a Senior Technical Officer in 1990. Camilla Lambert, who was recruited to Quaternary Research in 1949, and moved with her husband James Dickson to Glasgow in 1970, became a noted author on the palaeo-ecology of archaeological sites.

Near the end of Peter Barham's time, the burden of administration had become almost intolerable for the Chief Technician (and for the Head of Department!). When he retired, the Department was finally allowed to appoint a Departmental Secretary (i.e. administrator). This eased the burden, but the pressures on the Chief Technician have continued to be considerable, not least as a result of the many building operations in the late 1990s

PJG, EAS & SMW

Botanic Garden

The new Botanic Garden was opened in 1846, as a result of the vision of Professor JS Henslow. Initially resources were sufficient to develop only the western half of the 40-acre site purchased in 1831 from Trinity Hall. By 1895, when Marshall Ward was appointed Professor, the Botanic Garden was *de facto* a sub-department of the Department of Botany, as it is today. In practice, however, under R I Lynch as the Curator, the Garden had a good deal of independence. Born in Cornwall in 1850 and son of a head gardener on a private estate, Lynch was trained at Kew. Within two years of appointment as Curator at Cambridge at the age of 29 he had secured a substantial expansion of the staff. During his long tenure (40 years) he not only nurtured the woody collection, which forms the framework of the garden, but got a fine range of glasshouses built.

Under Lynch a strong connection between the Garden and the teaching in the centre of town was built up. In the late 1870s and the 1880s he embraced the new botany of Vines, Darwin and Gardiner, and started the practice of supplying material for 'class work'. As the numbers reading Botany increased, the amounts of such material came to be very large. The practice persisted for a century until courses on the variety of plants were much reduced. Lynch also developed a friendship with Michael Foster, the Professor of (Animal) Physiology whose help to Vines was so important (p. 2). Lynch shared with Foster a passion for growing *Iris*, and this hobby resulted in one of Lynch's few substantial published works – *The Book of the Iris* (1904). It also seems certain that Lynch was consulted by Marshall Ward when he was preparing his textbooks entitled *Trees* (five volumes, 1904–09). The cooperation of Lynch was vital for Bateson and Saunders, who carried out their ground-breaking genetical experiments in the Garden (see p. 20). In 1904 Bateson tried unsuccessfully to persuade the University to develop as an experimental area some of the allotment gardens to the east – an idea that came to fruition nearly 50 years later (see below). In January 1906 Lynch's great contribution was recognized by the University through the award of the MA degree *honoris causa*.

RI Lynch

Humphrey Gilbert-Carter, who was appointed the first Scientific Director of the Garden in 1921, was an enthusiast and inspired a whole generation of systematic botanists (see p.10). His *Guide to the University Botanic Garden Cambridge*, a marvellously idiosyncratic text scattered with quotations from Virgil's *Georgics*, Arabic and Indian languages, appeared in 1922. Although he could not have known it at the time, his

Iris hybrid cv. '*Caterina*' (*I. cypriana* x *I. pallida*) selected by Foster in 1908 and still growing in his garden on the Gog Magog Hills (photo by Anne Blanco White)

friendship with Reginald Cory of the wealthy coal-and-oil family was to change fundamentally the fortunes of the Garden. After World War I Cory, a Trinity College man like Gilbert-Carter, began to help the Garden financially, and in 1925 the Director was able to move into his new house, Cory Lodge. Cory died in 1934 and left his fortune to the Garden – about £200,000.

When John Gilmour succeeded to the Directorship in 1951, he and the Superintendent Bob Younger were able to use the Cory Fund to carry through a great expansion to the benefit of both the horticultural side of the Garden's activities, and the use of the Garden by the staff and students at the Botany School. The eastern half of the Garden land, under allotment gardens for more than a century since its purchase, was at last incorporated. It was allocated partly as a Research Area with its own glasshouses, and partly for public use. The splendid Cory Laboratory building was erected, one half for teaching and research, the other to provide attractive office and mess accommodation for the Garden staff.

The Tropical House, rebuilt in 1988–89, an invaluable resource for teaching

Under the Directorship of Max Walters (1973–84) the first Education Officer working with local schools was appointed. The Friends of the Botanic Garden organization was relaunched; it now has over 3500 members, and makes an important financial contribution. In these years Peter Yeo, Taxonomist and Librarian, and his assistant Clive King established an excellent documentation and recording system, and brought labelling of the collections to a very high standard.

When Donald Pigott was Director (1984–95) the central part of Lynch's glasshouse range (the Tropical House) was rebuilt magnificently, an unparalleled resource within a University for the teaching of tropical botany. The Gilmour Building was put up primarily to provide fine facilities for meetings and social functions in the Garden, an office for the Friends and a cafeteria, but has also proved invaluable for teaching larger groups from the Botany School. However, the late 1980s and early 1990s were a period of retrenchment financially. In order to rebuild the Cory Fund capital, so as to meet the costs of employing Garden staff and to provide for new developments, the Managers felt forced to lease the 1 Brookside building that had housed the Garden's offices since 1947, and to sell off 47 Bateman Street which had housed controlled-environment chambers for ecological research and facilities for the recreation of the Garden staff. The offices moved to Cory Lodge, and the Director lived in Brooklands Lodge on the western limit of the garden. New plant growth rooms for the ecologists were built in the roof of the Cory Building. Charges for admission were introduced in 1994. Nevertheless the future of the Garden was under serious threat, and the appointment of a new Director was delayed for a year, requiring the Professor of Botany (Tom ap Rees) to take over the role. Fortunately a General Board report strongly supported the continuance of the scientific Directorship.

Since John Parker's appointment as Director in 1996 there has been a wide range of new developments, including the upgrading of the Cory Lab to the standards needed for research in molecular biology, a great expansion of the use of the Garden by schools and the erection of a new classroom for teaching. The present Director is also more involved in the teaching of the Department than any previous one. The glasshouses in the Research Area are to be rebuilt in the near future, and there are plans for a large visionary modern building on the south-western side of the Garden to house an interpretation centre and new offices. The Botanic Garden has become once again closely integrated with the research and teaching activities of the Downing Site staff, and as far as the general public goes, the garden has never been so popular or so well used. SMW

Recent developments and future plans

As the preceding accounts make clear, the Department's research over the last 100 years has covered all aspects of botany, and most of today's activities are a logical extension of past interests, albeit with different methods, paradigms and approaches. The Department retains a broad coverage of plant sciences based on a philosophy that plants should be studied for their intrinsic interest as much as for their potential for exploitation as crops or sources of useful products. This is reflected in the research of the current staff which emphasizes basic biological problems at a range of levels from molecular biology to ecology, including interactions between plants and other organisms, particularly plant pathogens.

The Department is recognized as a unique part of the spectrum of biology in Cambridge and is one of the few remaining university departments in the UK dedicated solely to the study of plants. The Department cooperates closely with other Departments, notably Zoology, Genetics and Biochemistry in both teaching and research and has good links with research institutes such as the John Innes Centre and Rothamsted Research.

Staff

Since 1996, the Department has recruited eleven new members of Academic Staff (chronologically: Julia Davies, Tim Upson, Roger Leigh, Jim Haseloff, Beverley Glover, Julian Hibberd, Thomas Martin, David Coomes, Howard Griffiths, Gina Murrell and Alex Webb) both through the creation of new posts and as replacements for retired staff. This has resulted in significant shifts in the balance of research, with the loss of palaeobotany and mycology and the strengthening of molecular physiology, plant development and ecology. The aim has been to maintain a balance across the spectrum of research and to provide continued leadership e.g. by the creation of a new Professorship of Plant Ecology. Recently, the University agreed to establish a Professorship of Plant Systematics and Evolution, with the expectation that the appointee will give a national boost to training in this area and will exploit the valuable collections in the Herbarium and the Botanic Garden.

The Department has been lucky in being able to maintain a skilled and dedicated group of technicians that, until recently, allowed it to provide individual assistants to all academics. This is no longer the case, as financial constraints have meant that posts had to be lost. Discussions are now underway to decide how the remaining technicians can be deployed to make best use of their skills, to maximise the benefits to teaching and research, and to ensure job satisfaction for all.

Research Infrastructure

By the early 1990s it was clear that lack of investment meant that the laboratories and other facilities in the Department were inadequate and were a constraint to the Department competing at an international level in research and in recruiting students. Tom ap Rees began a programme of refurbishment that was in progress at the time of his death in 1996. To its credit, the University recognised the need to continue to improve the Department and since the appointment of Roger Leigh in 1998 has invested considerable sums in a major refurbishment of the research and teaching laboratories, as well as the general appearance of the building (see p. 9). While a few rooms have still to be modernised, there are now none that are inadequate for their purpose.

Welcome though these improvements have been, there is still more to do. We have recently learned that the Department is to receive very considerable funds that will allow a new plant growth facility building to be constructed in the Botanic Garden. We have also begun fund-raising for a new Herbarium, also to be based at the Botanic Garden. The Herbarium development is considered particularly important since it will reunite the two great botanical collections in Cambridge for the first time since the 1840s (see pp. 5 & 28). It will also allow a new research focus in Plant Systematics and Evolution to be established at the Botanic Garden.

In the post-genomic era, biology has become 'big science' and future success will require greater cooperation between research groups and Departments. How this will be achieved in Cambridge is currently under discussion. Within the

Department, the emphasis on individual achievement is changing to one that promotes more collaborative interactions between groups. In future it is likely that the Department will focus on areas of research where it has recognisable strengths such as photosynthesis and metabolism, membrane transport and signalling, development, and ecology. This consolidation will also be driven by the need for groups to share expensive and sophisticated technologies.

Teaching

The Department has always had a strong belief in the importance of teaching and its undergraduate and postgraduate students find it supportive and friendly. As with research, the Department teaches across the whole spectrum of plant biology. The second-year course on Plant and Microbial Sciences allows students to experience all aspects of the subject and to appreciate the unique biology of plants and microbes. The third-year Plant Sciences course is more specialist, giving students an opportunity to focus on aspects of their choosing. In 2003/04, the Department has 47 students taking its second year course and 25 studying Plant Sciences as their third-year option. This makes it one of the most important centres for training of plant biologists in the UK.

Drawing by the architects (RH Partnership, Cambridge) of two new buildings to be erected at the Botanic Garden, on the left the Plant Growth Facility and on the right the Herbarium; the east end of the Cory Laboratory appears on the right

The Department has been instrumental in introducing innovations in curriculum development both in its own courses and those taught jointly with other Departments. For instance, in the 1960s and 1970s it was a key player in the development of several important inter-departmental courses, notably the first year courses Biology of Cells and Biology of Organisms and second-year Ecology. In the 1980s it played crucial roles in developing inter-departmental third-year courses on Development, Population and Community Ecology, and Tropical Ecology. Most recently, it has helped to develop two new first-year courses on Physiology of Organisms and Evolution and Behaviour. Within its own courses, the Department is continually seeking to introduce improvements, the most recent being a redesign of the second-year course in 1999 to provide more integration of molecular and ecological aspects of the subject and, subsequently, an increase in the microbiological content to fill a gap in the teaching of non-medical microbiology. The third-year course has been modularized giving more integrated specialist topics and greater emphasis on novel methods of teaching delivery. These changes have been helped by state-of-the-art audio-visual facilities in the main Lecture Theatre and in the smaller Tom ap Rees teaching room

Concluding Remarks

Like the last, the coming century will see further developments in Plant Sciences in Cambridge. We are confident that, whatever the challenges that lay ahead, the Department is in a good position to meet them and will maintain its international prominence as a centre for broad-based, fundamental studies of plants. Given the quality of the staff, students and facilities, and the strong past record of achievement, there is every reason to look with confidence to another century of significant contributions to our subject.

We are extremely grateful to the three authors for producing this historical booklet.

John Gray, Professor of Plant Molecular Biology and Head of Department

Roger Leigh, Professor of Botany

The Tea Phytologist

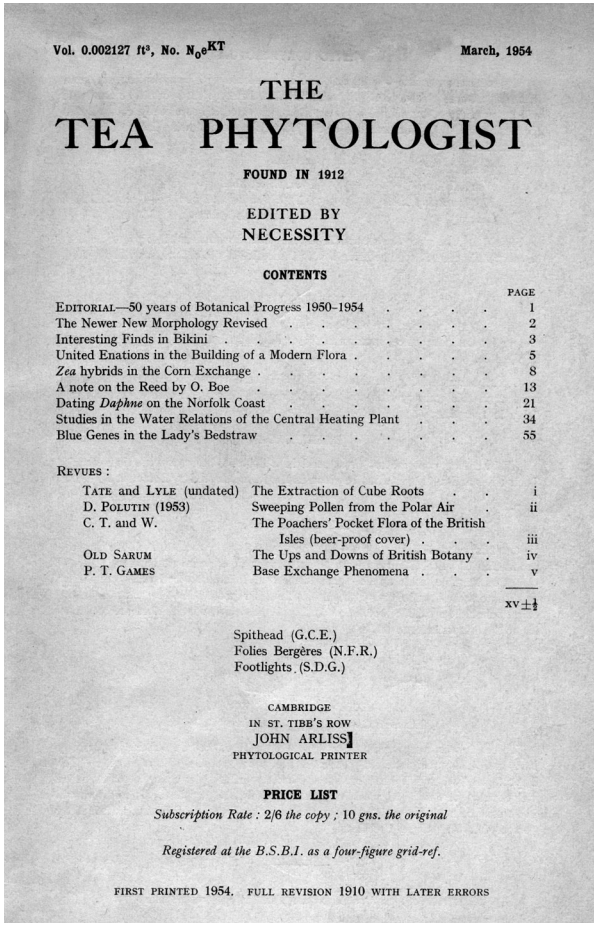
Like so many developments in Cambridge Botany, *The Tea Phytologist*, 'an occasional publication', was obviously stimulated by Tansley, whose own journal *The New Phytologist* had been founded in 1901. Tansley joined the Botany School staff in 1907, and the first number of *The Tea Phytologist* appeared in the following year. Godwin (1985, *New Phytologist*) tells us that it was 'put together by the gatherings of folk at the tea-table, advanced Tripos students and research workers for the most part' and that it was 'full of humorous references to the local botanical personalities, comic citation and jibes at the students' own activities'. After the two initial numbers, both dated 1908, this remarkable journal has appeared – in Godwin's phrase – 'with devastating irregularity'. The most recent number, dated (correctly !) March 1984, contains an editorial page with the motto *Hinc lucem et pocula theae* – an irreverent bowdlerization of the University's own motto! The Departmental Library contains a file with a set of 13 issues and related material, but we do not know how complete this archive is, or of any other holding. SMW

Some pearls follow.

'... this may be tested by lowering into the gas jar a glowing spinster'

'This stage is dependent on dry external conditions because on a damp day the atmospheric pressure is less than on a dry day, and the atmosphere would be unable to support the spores sufficiently to carry them any distance.'

'... until it reaches the xylem, and from there it has got absolutely nothing to stop it from going up the plant as the xylem is long and empty.'



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