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Obituary

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Michael Black ('Mike') was born in February 1932 in Manchester, England, the third child of Mary and Reuben, a salesman in the garment trade, and about 10 years younger than his sister and brother.

Education and career

While a student at Stand Grammar school, Mike discovered his lifelong interest in science, particularly in plant biology, getting his first taste of practical field research and finding his flair for presenting results to his contemporaries. Mike went to study science at the University of Manchester from where he graduated with a BSc in 1953, specializing in botany. He stayed there for his research degrees under the supervision of Professor Philip Wareing, whose particular interest was in the growth and development of woody species. He studied the complexity of dormancy behaviour in birch seeds, and he obtained his MSc in 1954 and his PhD in 1957. Next, he took a postdoctoral fellowship at the University of Saskatchewan, Canada, to study dormancy in wild oats with Jim Naylor in the Department of Field Husbandry. Returning to the UK in 1959, he had a short-term research position at the University of Wales, Cardiff, in the laboratory of Professor Herbert Street, a pioneer of plant cell and tissue culture. Then, in 1960, he joined the Department of Biology as part of the expanded and newly independent Queen Elizabeth College (QEC), in the University of London, with its large purpose-built research and teaching facility in Kensington. There he developed his career over the next 40 years, teaching and building his research group, largely studying seeds and seedlings, rising from the position of Assistant Lecturer to full Professor, and eventually becoming an Emeritus Professor. After 1990, with greatly reduced teaching load and departmental management roles, he was able to concentrate on his experimental research programmes and his writing projects, and to conduct mini-sabbaticals, such as at the Pierre and Marie Curie University in Paris (with Professors Côme and Corbineau). In 1985, QEC had been re-amalgamated with King's College, its original parent in central London, and Mike continued to give some lecture courses there for 2 years after the Kensington site closed in 2000.

Research

Here, we touch upon only a selection of Mike's many research topics and interests, with a few brief illustrations of some of his findings and accomplishments.

Mike's biggest research subject was the development, dormancy and germination physiology of seeds. Of particular, research interest to him were the timing and degree of responses to different spectral compositions of light and the interplay between endogenous hormones and inhibitors that accumulated and changed during seed development, maturity, drying and storage and after imbibition – the working out in detail in seeds of the 'hormone concept'.

In his PhD studies of birch seeds (*Betula*), for example, which ordinarily require light for germination, Mike found that when the pericarp is removed the 'isolated' embryo germinates in complete darkness, which appears to be due to enhanced oxygen entry (because scratching or pricking the seed coat has a similar effect). He also demonstrated that a water-soluble inhibitor present in the pericarp restores the block on germination, apparently by increasing the oxygen requirement of the embryo, and also that high oxygen concentrations reduce the requirement for light in intact seeds.

From his studies of wild oats (*Avena fatua*) came a novel discovery that placing seed-bearing shoots in a solution of gibberellic acid at an early stage of grain development, which allowed for the hormone to be taken up, prevented the onset of the deep dormancy

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associated with that species, imposed by a then-unknown inhibitor. The implication here was that seeds' hormone content acquired during development strongly influenced subsequent germination.

His research programme at QEC over the years continued to focus on seed germination and dormancy. Mainly to begin with he studied the lettuce seed (*Lactuca*), deducing the interplaying roles of gibberellin and light and the timing of their influence following imbibition in light or darkness. One novel conclusion, for example, was that in order for applied gibberellin to promote germination a low amount of phytochrome as Pfr must be carried over from ripening and maturation, and if that is removed, either by far-red light or by slow thermal loss, insensitivity to the gibberellin results.

In other research, he investigated ways in which the conditions a seed is subjected during its development and maturation affect its behaviour after germination. Using barley and wheat grains (*Avena sativa* and *Triticum aestivum*), for example, Mike and his colleagues showed that the well-known gibberellin-induced synthesis of hydrolytic enzymes (such as of α -amylase and β -1,3-glucanase) in the aleurone layer following germination can only operate after the mature grain has been dried. This maturation-drying converts the aleurone tissue from a developmental mode to a (post-)germination mode, and dependence on this switch plays a critical role in retaining the integrity of storage reserves until after the seed is dispersed from the mother plant, only making them available following germination to support seedling growth. There are practical grain-quality implications of his work, which for example helps explain why there is spoilage of mature dry grains if they are rewetted before harvest; and 'preharvest sprouting' is now a much-studied subject.

Mike was also interested in the physiology of seedling growth, and he made an early overview of the subject in his book with Jack Edelman, 'Plant Growth' published by Heinemann Educational Books in 1970. He went on to develop programmes to study the photocontrol of hypocotyl extension in green de-etiolated seedlings. With his co-workers in 12 papers, he characterized the complex synergisms within the growth-inhibitory responses in light-grown cucumber (*Cucumis sativus*) seedlings, by elegant experiments using different spectral compositions, changing fluence rates and physical masking, and the electronic measurement of the magnitude and kinetics of the growth responses. They showed for instance that the hypocotyl growth-inhibition is mediated by two photoreceptors: by cryptochrome (the blue-light photoreceptor) in the hypocotyl within 5 min of illumination; and by phytochrome (the red-light photoreceptor) both in the hypocotyl and also in the cotyledons and transmitted by them, which takes 5 h.

Mike was generous with his ideas for potential projects that could benefit progress by other researchers, even though he did not necessarily participate further himself. One example was his observation (reported in a 1968 presentation at a Symposium of the Society for Experimental Biology on 'Seed Dormancy and Survival') that upon placing leaves of common lime (*Tilia x europaea*) in a spectrophotometer, the major penetrating wavelengths are in the far-red region of the spectrum. The clear ecological inference was that the canopy beneath a leafy tree presents a hostile environment preventing the germination of red- or blue-light requiring seeds. Though Mike did not follow up on it himself, this potent observation spurred others to conduct extensive research on this new ecophysiological aspect of the subject.

International seed science

Mike's writing and editing of a notable succession of books over the course of three decades is arguably one of his most prominent intellectual contributions to academic seed science – and his lasting legacy. Through these books, with his co-authors and co-editors, he communicated the scope and depth of his grasp of the whole subject, and greatly facilitated its teaching.

His first major accomplishment in this sequence was 'Physiology and Biochemistry of Seeds in Relation to Germination'. Springer-Verlag had personally approached him about this concept and as co-author he co-opted Derek Bewley of the University of Calgary, who had been his first graduate student. Together they wrote during writing-sabbaticals, with Mike very much the guiding light and mentor; and thus was born the 'BewleyandBlack' partnership, as some later named their 'publishing brand'. The book was published in two volumes: '1. Development, Germination and Growth' in 1978, and '2. Viability, Dormancy and Environmental Control' in 1982 (most of the latter written by Mike). These books were so successful that a single-volume was commissioned by Plenum Press: 'Seeds: Physiology of Dormancy and Germination', aimed both at graduate students and teachers whose main interests were not in seeds. Both the first edition published in 1985 and an updated second edition in 1994 were well received.

Two more books followed at Mike's initiative, both involving chapters by multiple authors. 'Seed Technology and its Biological Basis' (co-edited by Black and Bewley) was published in 2000 jointly by Sheffield Academic and CRC Press. Then, in 2006, the 'Encyclopedia of Seeds. Science, Technology and Uses' was published by CAB International (co-edited by Black, Bewley and Halmer) – a project requiring the input of 112 authors including the editors, and in its 864 pages an enormous editing commitment. This scholarly reference work comprehensively covered 'all the major scientific themes and facets of the subject of seeds – both the latest fundamental biological knowledge, and the principles of agricultural seed processing, storage and sowing, the food and industrial uses of seeds, and the roles of seeds in history, economies and cultures'. In addition, he was also greatly involved in co-editing two large collections of presentations delivered at international seed symposia and workshops: 'Basic and Applied Aspects of Seed Biology' (Ellis, Black, Murdoch and Hong; Kluwer Academic, 1997) and 'Seed Biology. Advances and Applications' (Black, Bradford, Vazquez-Ramos; CAB International, 2000). An extensive work by invited authors, edited by Black and Pritchard, 'Desiccation and Survival in Plants. Drying without Dying', was published by CAB International in 2002.

Mike's second great contribution, matching the production of his books, was in being the key inspiration and promoter of the two key current vehicles of international seed science research: the 'International Society for Seed Science' (ISSS) and the journal 'Seed Science Research' (SSR), which came about as follows.

In the spring of 1980, Alfred Mayer invited several leading seed researchers, including Mike, to participate in a workshop in Jerusalem on 'Control Mechanisms in Seed Germination'. Its success prompted the organization of five more international workshops over the next two decades in different locations. In 1999 at the sixth workshop in Merida, Mexico, Mike successfully introduced the concept of the ISSS: a Society with the mandate to nurture and promote research, education and communication in the scientific understanding of seeds, and to be the umbrella under

which future international meetings would be organized. For this achievement, he was awarded an Honorary Lifetime Membership of the Society, and now at the international meetings a young researcher whose work is novel and pioneering is invited to deliver the 'Michael Black Founder's Lecture' in his honour.

For some years before that, Mike had become convinced of the need for a journal to specifically publish basic scientific research on seeds, both original papers and reviews, spanning across the physiology, biochemistry, molecular biology and ecology of seeds, which up till then had been dispersed across assorted other journals. In 1990, he approached CAB International who enthusiastically embraced the establishment of the quarterly '*Seed Science Research*' journal. The first edition rolled off the press in March 1991 with Mike as its founding Editor, and he handed over the editorial mantle after Volume 8 in December 1998, as the journal became the official publication of the newly established ISSS. By the end of 2022, Volume 32 was released.

Retirement and after

Throughout his years of full retirement Mike was very active in his local science branch of the University of the Third Age ('U3A'): organizing and chairing meetings, many of them online from his house, and he composed new presentations ranging in topics across the biological sciences. He also published in 2009 his appreciation of the understanding of seeds by Charles Darwin, and in 2015 a long essay on the discussions of seeds by the medieval English botanist John Ray.

The person

Mike had a notably enquiring mind, and devoted his life to learning and teaching. His pleasure and enjoyment came from making

scientific discoveries and explaining what he had found, and from generating ideas to prompt others. His gifts as a writer and speaker were considerable. He took great pride in promoting internationally the field of seed science to rising generations of scientists.

He was friendly and warm, with a lively wit and sense of merriment. Laughter was always near when he was there. He had the knack too of preparing some touch to make an otherwise formal speech memorably funny.

Fundamentally modest, Mike was not personally ambitious for awards or public recognition. He would sometimes reflect that throughout his whole professional career his reward and great good fortune was to be employed for simply doing what brought him such satisfaction and fulfilment.

Mike met his wife-to-be Marianne at QEC, and they made their home for almost 60 years in north London, where he kept their garden stocked with flowers, and their cellar with wine. There they raised their three children; and in the fullness of time came four grandchildren. Together they relished London's rich cultural life – with frequent visits to the theatre, concerts and the opera. An avid and very skilful squash player, Mike was also a keen cyclist and he would regularly commute to work through busy streets – even the nine miles into central London, and on a couple of long-distance charity rides too – and he was bicycling around to his local shops well into his 80s.

Mike was diagnosed with a melanoma in 2017, and considered himself very lucky that immunotherapy kept it well under control for over 5 years, without any symptoms or detectable spread. But from the late summer 2022, other problems became apparent, without prospect of remission or further therapy. Mike died peacefully, in January 2023, surrounded by his children, Marianne having died in 2019.