Editorial: Biographical Memoirs, Volume 70

BY MALCOLM LONGAIR

WELCOME

Volume 70 of Biographical Memoirs contains a very rich menu of remarkable personalities and the science they pursued. By chance fluctuations, this edition has a preponderance of chemists and physicists, but the fields represented span a huge range of disciplines from agriculture to the fundamentals of quantum field theory. The 23 Memoirs include two Foreign Members (Luca Cavalli-Sforza and Henry Taube) and three Nobel Prize winners (Sir James Black, Sir Charles Kuo and Sir Peter Mansfield). The roll-call includes three other distinguished knights of the realm (Sir Tom Kibble, Sir Philip Randle and Sir Rex Richards).

NOBEL REFLECTIONS

The Memoirs of the three Nobel Prize winners listed above make it clear why they deserved these honours - the authors of these Memoirs describe clearly the routes to their discoveries, inventions and innovations. The Nobel Committee often has very difficult judgements to make and we acknowledge that the process is carried out in good faith and in as unbiassed a fashion as the best selection committees can achieve. Nonetheless, there are omissions which are sometimes a bit of a surprise. Perhaps the best-known case is that of Fred Hoyle whose discovery of the triple-alpha resonance in the formation of helium out of four protons and who predicted its energy precisely were the keys to the understanding the formation of the chemical elements and the source of energy of our Sun. It could have happened so easily since only two Nobel prizes were awarded for ‘…theoretical studies of the physical processes of importance to the structure and evolution of the stars’ to Subrahmanyan Chandrasekhar and William Fowler in 1983, when three prizes in Physics were allowed. Hoyle’s maverick streak was well known to his many colleagues and admirers, but no one can gainsay the brilliance of his insights, which came as a surprise and revelation to the nuclear physicists.

These reflections were inspired by two of the Memoirs in this volume. Perhaps the more poignant is that of Tom Kibble. The last paragraph of the Memoir brings out clearly the dilemma facing the Nobel Committee. Three groups were involved in the theory of the symmetry breaking which resulted in the prediction of what came to be known as the Higgs boson: Brout and Englert at the Université Libre de Bruxelles, Higgs at Edinburgh and Guralnik, Hagen & Kibble at Imperial College London. Brout died in 2011. The 2013 Nobel Prize in Physics was awarded to Englert and Higgs. It was a surprise that Kibble was not...
honoured. As Steven Weinberg wrote on the occasion of Kibble’s 80th birthday, ‘Tom Kibble showed us why light is massless’. The Memoir concludes with the words: ‘Indeed Higgs said that Kibble should have shared the 2013 Nobel Prize awarded to Englert and himself “because of what he wrote in 1967”. Kibble himself maintained a dignified modesty throughout in keeping with the honesty and integrity for which he was justly famous.’

The other case is that of John Ward, one of the pioneers of quantum field theory. As his remarkable Memoir makes clear, Ward was a brilliant loner who was recognized as a theorist of exceptional ability. His great discovery was what became known as the Ward identities which played a central role in the construction of quantum field theory. Freeman Dyson, who died recently and was another whose theoretical discoveries were undoubtedly at Nobel Prize level, commented that ‘Ward and I had an approximately equal share in the evolution of QED into its modern shape’. But Ward was not the easiest of characters. He passed up opportunities to settle into a distinguished academic setting, for example, by turning down the offer of a senior academic post in Oxford University, instead taking up an essentially teaching role at McQuarrie University in Australia. This was followed by a period at Aldermaston where he helped unravel the Ulam-Teller design for the hydrogen bomb. He received little recognition for this work, resulting an unhappy exchange with Prime Minister Margaret Thatcher about the lack of recognition of his work. To quote from the Memoir, ‘John Ward ended up an embittered man. . . . he became obsessed with the lack of recognition of his achievements. At the end of his life he was a tragic figure, isolated by his own querulous complaints.’

These cases bring home to me how important the Biographical Memoirs are in recognizing the real importance and quality of those celebrated. With our aim of concentrating on the originality of their scientific discoveries and contributions and how they came about, the authors of the Memoirs provide a lasting authoritative assessment some of the greatest minds who were Fellows of the Society. These thoughts reinforce my conviction of how important the Memoirs are in recording the scientific achievements of the Fellowship and how much we owe to the authors of the Memoirs for their unstinted efforts.

Biographical Memoirs Volume 70

There are 23 memoirs in this, the first 2021 volume of Biographical Memoirs. The following notes are intended to act as a guide to the different disciplines represented, with brief summaries of the achievements of the Fellows, largely taken from the memoirs’ summaries. These, and previous volumes, can be freely accessed on the Royal Society’s website.

Agriculture

Duncan Greenwood’s early studies on soil aeration revolutionized thinking about the mechanisms by which oxygen influences the activity of microorganisms and the metabolism of organic substances in structured soil. Later he studied the nutritional requirements of vegetable crops at a time when the horticultural industry was starting to introduce inorganic fertilizers. He developed a novel static model of N, P and K response producing the first scientifically based inorganic fertilizer recommendations for 23 different vegetable crops.
CHEMISTRY

Cecil Bawn was a physical chemist with particular expertise in chemical kinetics. He was one of the pioneers of polymer chemistry and established and led a strong and diverse group of polymer scientists at the University of Liverpool. Nationally, he made outstanding service contributions to physical chemistry and polymer chemistry.

Richard Chambers was one of the most creative and distinguished organofluorine chemists of his generation. He synthesized a range of perfluorinated heteroaromatic systems and established their chemistry and associated reaction mechanisms. New ranges of stable, observable perfluorinated carbanions, alkenes and dienes were synthesized and their fundamental chemistry established. His research into the use of elemental fluorine gas established fluorine as a viable reagent for organic synthesis.

Malcolm Green’s infectious passion for science and his imaginative approach led him in many diverse directions. Although his signature field was organometallic chemistry, he made important contributions in nanomaterials and heterogeneous catalysis. He pioneered several new and imaginative methods for interpreting and understanding chemical bonding and reactivity, such as the Covalent Bond Classification scheme with Parkin, and, with Mingos and Davies, the rules for predicting the regiochemistry of nucleophilic attack on organometallics.

Basil Lythgoe collaborated with Alexander Todd on the structural elucidation and total synthesis of the natural nucleosides, and was noted for his investigation of the structure of the natural substance macrozamin. In 1953 he moved to the chair of organic chemistry at the University of Leeds where he worked on the structure of the alkaloid taxine 1 and calciferol, amongst other natural substances.

Jake MacMillan was a pioneer in the field of bioorganic chemistry, practising what we now call synthetic biology 40 years before the term was coined. His multidisciplinary approach to tackling major problems at the chemistry–biology interface was influenced by his early research working in the famed Butterfield (later Akers) Laboratory set up by ICI. There, he isolated and elucidated the structure of the important antifungal agent griseofulvin, before initiating his life-long interest in the gibberellins. He became the world authority on the chemistry, biosynthesis and biology of the gibberellins.

Henry Taube became the world’s premier mechanistic inorganic chemist through a lifetime of increasingly broad and significant experiments and discoveries. He focused on the chemistry of transition metal complexes, laying out the details of what he called ‘inner sphere electron transfer’. He went on to compile a broad range of findings, leading to the elevation of inorganic chemistry to a major field of study.

GENETICS, MOLECULAR AND DEVELOPMENTAL BIOLOGY

Luca Cavalli-Sforza dominated the field of human population genetics in the second half of the twentieth century. He pioneered both genetical demography and the construction of the genetical evolutionary tree of man, initially from gene-frequency data and ultimately from tracing the paths of descent of individual DNA sequences. He conducted expeditions to study the Pygmies of the African rainforest and the spread of agriculture in Europe, demonstrating the similarity between its wave of advance and the contours of population gene
frequency. He noted the correspondence between the descent tree of languages and the human evolutionary tree and brought an informed and rational approach to the problems of human diversity.

**Gordon Dixon** developed the technique of starch gel electrophoresis with Oliver Smithies and made important discoveries on the structure of human haptoglobins. He subsequently contributed to the determination of the structure and active sites and mechanisms of action of trypsin and chymotrypsin and made seminal discoveries related to understanding the structure of the protein hormone insulin. He is best known for his later studies on the regulation of protamine genes and chromatin transitions in spermatogenesis and is often considered to be the father of the protamine molecular biology underlying this gene.

**Anne Warner** applied physiological techniques to developmental biology, elucidating the mechanisms of cell interaction and communication that pattern the early embryo. She contributed crucial discoveries in the fields of muscle physiology, cellular differentiation and gap junction communication. She was the first to show that embryonic development and patterning required gap junctions, and that the restriction of junctional communication between cells played a key role in tissue differentiation.

**Immunology, Physiology and Pharmacology**

**Edward Boyse** was a master of the field of cell surface immunogenetics which relied heavily on the use of his congenic mouse strains, and on his improved methods for reliable serology. He founded the new discipline of odourtype genetics, revealing how immunohaplotypes were involved in assortative mating and related behaviours, thus promoting heterozygosity. He pioneered the field of cord-blood cryopreservation and transplantation, conducting the first laboratory studies in mice and assembling the clinical team that performed the first human cord-blood transplant.

**James Black** was a pharmacologist who was awarded the 1988 Nobel Prize in Physiology or Medicine for his drug invention method, which was to build molecules around the structure of a natural chemical activator of a pathway involved in the aetiology of a disease. This produced two extremely useful drug categories, beta-blockers and histamine H2-antagonists, with huge impact on the previously intractable diseases of angina, hypertension and stomach ulcers.

**Philip Randle** was one of the world’s foremost researchers into mammalian metabolism. He provided a series of brilliant insights into the fundamental mechanisms that determine the selection of metabolic fuels by muscle and other tissues. Many of his findings were concerned with the role of insulin including the control of its secretion from the \( \beta \)-cells in the pancreatic islets of Langerhans and with the regulation of glucose oxidation through changes in the activity of pyruvate dehydrogenase. The ideas generated by his investigations have had a direct bearing on the understanding of diabetes.

**Physics, Engineering and Astronomy**

**Philip Burke** made major contributions to the development of theoretical and computational atomic and molecular physics in the second half of the 20\(^{th}\) century. He developed and used the R-matrix method in the study of the interaction between atoms and molecules and their ions,
as well as with light and electrons. He established a number of Computational Collaborative Projects, providing a forum for scientists working in specific scientific disciplines to meet periodically to discuss current issues and how the ever-advancing cutting-edge of high-end computing could begin to address previously intractable problems.

Charles Kao was the pioneer who in 1966 suggested using glass fibre waveguide as a means of carrying laser-light over long distances for telecommunications. Within a few years, in a brilliant set of spectrophotometric experiments, Kao demonstrated that pure silicon dioxide materials exist that have the required very low attenuation. Kao was awarded the 2009 Nobel Prize in Physics for his ‘groundbreaking achievements concerning the transmission of light in fibres for optical communication’.

Tom Kibble was an internationally-renowned theoretical physicist whose contributions to theoretical physics range from the theory of elementary particles to modern early-universe cosmology. One of Kibble’s most important contributions was his study of the symmetry-breaking mechanism whereby the force-carrying vector particles can acquire a mass, accompanied by the appearance of a massive scalar boson. This idea lies at the heart of the Standard Model and all modern unified theories of fundamental particles. It was vindicated in 2012 by the discovery of the Higgs boson at CERN.

Devendra Lal was an Indian nuclear physicist who used tracks in nuclear emulsions to study cosmic ray particles and their interactions. His career revolved principally around multiple aspects of cosmic rays, employing theory and experiment to examine their flux, chemical composition and energy spectrum both at present and in the past through studies of particle tracks in the minerals of meteorites and lunar samples. He played a major role in developing approaches for the use of terrestrial cosmic ray produced isotopes as dating tools and tracers for a wide range of earth science processes, from biological cycles in the ocean, to landscape evolution, and ice ablation in the Antarctic.

Peter Mansfield developed the underpinning methodology for nuclear magnetic resonance (NMR) imaging. In the early 1970s, nuclear magnetic resonance was an analytical tool, ubiquitous in chemistry departments. There was no hint that it could be developed into a diagnostic imaging technique that would reveal internal anatomy in unprecedented detail. The first MRI scans were slow, and he was driven to speed them up, making physiological and later functional brain imaging studies possible. In 2003, he shared the Nobel Prize for Physiology or Medicine in recognition of his achievement.

Leon Mestel was best known for his wide-ranging work on cosmic magnetism, but he also worked on an equally wide range of non-magnetic problems in astrophysics, from star and galaxy formation to white dwarf cooling. His life’s work culminated in the publication of two editions of a magisterial monograph on stellar magnetism. He collaborated widely, influenced many researchers and was in great demand as a conference speaker.

Rex Richards was renowned for his research in the field of nuclear magnetic resonance (NMR). In the late 1940s, when NMR was in the domain of physicists, he foresaw that the technique might play an important role in chemistry. His highly successful research career combined the design and development of new NMR spectrometers with novel applications, initially in chemistry and subsequently in the biological sciences. He also had highly impressive administrative skills, as recognised through successive appointments at the University of Oxford as Head of the Physical Chemistry Department, then Warden of Merton College, and finally Vice-Chancellor.
John Ward made important contributions quantum electrodynamics and electroweak theory. An early proponent of gauge theories in quantum field theory, he used these to demonstrate that the renormalisation of those theories removed apparent infinities in calculations. He showed that gauge invariance implies the equality of two seemingly different renormalised quantities in QED, a relationship now known as the Ward Identity which remains a fundamental tool of particle physics. In 1955 he joined the UK Atomic Weapons Research Establishment to head the Green Granite section of the theoretical group, tasked with rederiving the thermonuclear weapons concepts developed by Ulam and Teller in the United States.

ZOOLOGY

Charles Ellington developed novel methodologies for the kinematic analysis of freely hovering insects. He identified five new non-steady-state mechanisms for lift generation and was the first to develop a vortex theory for flapping flight. Building a closed-circuit wind tunnel connected with a sensitive oxygen analyser, he studied how the aerodynamics and metabolic power input of bumblebees vary with flight speed. Outstanding among later research was the discovery that hawkmoths, and by implication many other insects, gain high levels of lift by generating a vortex above the leading edge, stabilised by spiralling out along the span.

Ralph Lainson was a distinguished protozoologist and a parasitologist of many abilities. He was a ‘traditional protozoologist’, who aimed to understand how parasites were transmitted and related to each other. Although many of the organisms he discovered were associated with a disease, he openly admitted that his ultimate interest would always be the parasite. His research methods were simple, but he would readily embrace a new technology if it helped solved a problem.

ACKNOWLEDGEMENTS

First, let me repeat our gratitude to the authors of the Memoirs for their outstanding work in writing biographies of lasting value, particularly during this extremely difficult year for everyone. These authoritative Memoirs are full of interest and pleasure for the insight they provide into the lives and works of a number of outstanding scientists. We are grateful to the United States National Academy of Sciences (NAS) for allowing us to re-publish their Memoir of Henry Taube. I am also personally indebted to the Editorial and Production teams at the Royal Society, whose names and roles are listed on the title page. Their outstanding efforts have enabled us to continue the enhanced rate of publication of the Memoirs while maintaining the excellence of their content and high production values. It is a pleasure to acknowledge the efforts of the Editorial Board who have been very helpful indeed in supporting the increased activity by suggesting Memoir writers, helping with refereeing and keeping a sharp eye on all aspects of the evolution of Biographical Memoirs. On a more sombre note, we were very sad to learn of the recent death of Sir John Meurig Thomas, who has been a much-valued member of the Editorial Board since 2016 and was a staunch enthusiast for Biographical Memoirs.
AUTHOR PROFILE

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Malcolm Longair CBE FRS FRSE is Jacksonian Professor Emeritus of Natural Philosophy and Director of Development, Cavendish Laboratory, University of Cambridge. He was appointed the ninth Astronomer Royal of Scotland in 1980, as well as Regius Professor of Astronomy, University of Edinburgh, and the director of the Royal Observatory, Edinburgh. He was head of the Cavendish Laboratory from 1997 to 2005. He has served on and chaired many international committees, boards and panels, working with both NASA and the European Space Agency (ESA). His main research interests are in high energy astrophysics, astrophysical cosmology and the history of physics and astrophysics. The third edition of his book ‘Theoretical Concepts in Physics’ was published in Spring 2020. He has continued to enhance the online digital archive of historic photographs illustrating the history of the Cavendish Laboratory. He is also preparing for the move of the Cavendish Collection of Historical Scientific Instruments to the new Cavendish Laboratory in 2022.