Editorial

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WELCOME

Volume 71 of Biographical Memoirs begins with an appreciation of the late Prince Philip, HRH the Duke of Edinburgh, Honorary Fellow of the Royal Society. The prince’s dedication to science, and particularly engineering, and his support of the sustainability agenda, climate change initiatives, the need for biodiversity and an ecologically sustainable planet need little amplification. We have lost a distinguished British spokesman for science whose no-nonsense approach to these global issues has been greatly valued by all of us.

Prince Philip would have been heartened by many of the memoirs in this volume. They include Bob May, former President of the Royal Society and the leading theoretical ecologist of his generation. Altogether there are six memoirs in the areas of ecology, palaeontology and zoology, including a wonderful appreciation of Colin Pennycuick on the understanding of the flight of birds. There are six in the areas of biomedicine, physiology and cellular biology and three in engineering. Perhaps closest to the prince’s immediate interests are the two remarkable memoirs of Coluthur Gopalan and Calestous Juma in health and sustainable development. And there are two memoirs of outstanding women, Margaret Burbidge and Jennifer Clack.

DIVERSITY

These considerations resonate with the thoughts that always strike me as we compile the contents of each volume of Biographical Memoirs. It is not only the breadth of disciplines that is striking but also the diversity of background, approach and individual character which reinforces my conviction that individuality and diversity are keys to scientific success. Diversity and inclusiveness are at the heart of the agenda of the Royal Society and the learned societies, as well as full awareness of the importance of recognizing conscious and unconscious bias in all its many manifestations. Just a couple of examples of Fellows of diverse backgrounds will suffice.

Coluthur Gopalan’s pioneering research into the investigation and mitigation of the nutrition-related problems of Indians, especially those from disadvantaged sectors, and Calestous Juma’s application of science, engineering and innovation to the sustainability agenda in developing and developed countries are brilliant examples of frontline scientists channelling their enormous energies for the benefit of these countries.

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Margaret Burbidge and Jennifer Clack were brilliant scientists who made their indelible marks on science against a background of overt gender discrimination. The cover picture shows one of Margaret’s triumphs in being allowed to operate instruments of the Lick 3-metre telescope from the prime focus cage where she would remain all night—this was not something that was done by women prior to her mould-breaking initiative. The successes of Margaret and Jennifer were won by sheer force of character and not accepting that their disciplines should be the preserve of male scientists.

These are by now historical case studies and matters are gradually improving, thanks to the examples of those above and many others, but still far from ideal. If the Biographical Memoirs can make any contribution to these key issues for science it is that they demonstrate the diversity of backgrounds, ethnicity, upbringing, gender, and so on of Fellows of the Society, and their strength of character in overcoming what should be avoidable barriers to success. We aim to make these matters things of the past, but it will undoubtedly require the proactive efforts of all of us to make this come about. At least the historical case studies are there for all to ponder.

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There are 25 memoirs in this, the second 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 scientific achievements of the Fellows, largely taken from the memoirs’ summaries. These, and previous volumes, can be freely accessed on the Royal Society’s website.

Astronomy and physics

Margaret Burbidge was one of the great observational astronomers of the twentieth century. In 1957 she and her husband, Geoff Burbidge, made their pioneering contribution to astrophysics through their collaboration with Willy Fowler and Fred Hoyle on the origin of the chemical elements. Their paper of 1957 described the numerous nuclear processes that led to the synthesis of the heavy elements in stars. Margaret and Geoff were at the heart of the exciting early years of unravelling the properties of quasars. Margaret became a role model for women in astronomy, leading by example and making every effort to support future generations of women astronomers.

James Philip Elliot made important contributions to our understanding of the structure of atomic nuclei. In 1958 he proposed the SU(3) model, explaining rotational behaviour of nuclei in the context of the shell model. In the 1960s and 1970s he developed methods to extract properties of the nuclear interaction from the phase shifts of nucleon–nucleon scattering. From 1980 until his death, he contributed to the development of the interacting boson model of Arima and Iachello, and its microscopic understanding in terms of symmetries of the shell model.

John Field made major contributions to the physics and chemistry of solids. His research interests spanned a very wide range of topics, including the strength properties of solids, fracture growth, impact and erosion phenomena, shock physics, reactivity of solids, explosive initiation, lasers, acoustics and medical physics. He developed the best-equipped high-speed
camera facility in any university in Europe. Extensive use was also made of ultrasonics, optical and electron microscopy, mass spectroscopy and thermal techniques.

**Mambillikalathil Govind Kumar (Goku) Menon** made major contributions to the unravelling of the full complexity of the families of elementary particles. Goku’s contributions were central to establishing the standard picture of elementary particles. He will be remembered for his studies of the two- and three-body decay-modes of the charged kaon that gave rise to the ‘Tau–Theta’ puzzle signalling non-conservation of parity. He led a team that carried out experiments at great depths underground, in 1965 detecting an event in which a cosmic-ray neutrino interacted with rock producing an energetic muon. Later, he set a lower bound on the lifetime for the decay of the proton.

**Biomedicine, physiology and cellular biology**

**Geoffrey Burnstock** was a biomedical scientist who gained renown for his discovery that adenosine 5′-triphosphate (ATP) functions as an extracellular signalling molecule. His group found that transmission from sympathetic and parasympathetic autonomic nerves to smooth muscle was in some places not mediated by the accepted chemical messengers. Using biochemical, histological and electrophysiological approaches, he amassed evidence that ATP was this non-adrenergic, non-cholinergic transmitter. In the 1970s he proposed ‘co-transmission’ in which some nerves released ATP in addition to either noradrenaline or acetylcholine. He distinguished pharmacologically P1 receptors and P2 receptors and he proposed in 1985 that the latter embraced P2X (ion channel) and P2Y (G protein-coupled) subtypes.

**Iain Campbell** defined the study of proteins by nuclear magnetic resonance spectroscopy (NMR) in the UK, and was a towering international figure in biophysics and structural cell biology. He was a pioneer in the application of NMR methodology to whole cells, determining the world’s second and the UK’s first protein structure by NMR. He ended his career as one of the leading scientific lights in integrin adhesion and focal cell assembly.

**Leonard Goodwin** was responsible for developing chemotherapeutic agents against parasites for 24 years. In the 1940s to the 1960s he had lasting impact, through the establishment of five major drugs: sodium stibogluconate, for treatment of leishmaniasis; pyrimethamine, for malaria; piperazine, to combat ascariasis; bephenium, for ankylostomiasis; and phenanthridine derivates, to treat trypanosomiasis. Such agents also became important in veterinary medicine.

**David MacLennan** was known internationally for his research on the molecular mechanism of muscle contraction in human health and disease. At Wisconsin he published a series of elegant papers on the isolation and characterization of the mitochondrial ATPase and protein components of the electron transfer system. At Toronto, he shifted focus to determine how calcium regulates muscle contraction, concentrating on the role of the sarcoplasmic reticulum (SR). His early discovery of the \( \text{Ca}^{2+} \) ATPase pump that controls calcium uptake into the SR was the key to muscle relaxation.

**Ricardo Miledi** was among the foremost researchers in elucidating how nerves transmit signals across synapses. He demonstrated with Katz that influx of calcium into the presynaptic nerve terminal is the essential trigger for the release of the neurotransmitter that carries signals across to the postsynaptic cell. With Katz, he also introduced the technique of membrane
noise analysis to determine the properties of the individual ion channels opened by ACh, providing the first functional characterization of a single receptor with integral ion channel. With Barnard, he pioneered a new approach facilitating the study of neurotransmitter receptors and ion channels by ‘transplanting’ them from brain and other tissues into large *Xenopus* oocyte cells by injection of messenger RNA.

**Keith Vickerman** was a parasitologist and protozoologist who made major contributions to our understanding of the biology of African trypanosomes, the causative agents of human sleeping sickness and naga in cattle. What began as an exercise in electron microscopy led him to investigate two of the then outstanding problems of trypanosome biology: how the parasites manage the transition from the tsetse fly vector to its mammalian host and how they evade the host’s immune response.

**Chemistry, crystallography and biochemistry**

**Sir Leslie Fowden** founded the field of phytochemistry and was the world authority on plant amino acids. He was distinguished for the identification, characterization and biological function of a new category of nitrogen-containing molecules in plants, the non-protein amino acids. During his research career, he isolated at least 50 of these compounds from a wide range of different plant genera and established their structural diversity, metabolic and toxic functions and their scientific significance.

**Michael Woolfson** contributed enormously to the theory and practice of X-ray crystallography for almost 60 years. He extended the theory of ‘direct methods’, which provided a general solution of the crystallographic phase problem from the measured diffraction data alone, and provided tools to exploit the theory. His parallel work on the origin of the Solar System renewed interest in the capture theory, contributing numerous stimulating ideas to the general study of the origin and dynamical evolution of the Solar System.

**Developmental biology and genetics**

**Walter Gehring** was one of the most influential developmental biologists of the last 50 years. He was involved in a number of major discoveries that had a profound impact in the understanding of the genetic and molecular mechanisms of animal development, not only for the fruitfly *Drosophila* but for the whole animal kingdom. His laboratory was involved in a number of key findings: the first cloning of a Hox gene, the discovery of the homeobox, the enhancer trap method and the remarkable conservation of features of the visual system in metazoans.

**John Thoday** was influential in establishing genetics as an integral part of the undergraduate programme in biology at Cambridge. Some of his most significant work explored the genetic basis of quantitative traits and thus pioneered approaches to understanding the mechanisms behind responses to selection. This helped set the stage to uncovering genes in the multiple-gene systems that determine polygenic characters in fields from medicine to agriculture.

**Ecology, palaeontology and zoology**

**Jennifer Clack** dedicated her entire research career to the fish–tetrapod transition, the evolutionary process during the Devonian and Carboniferous periods that transformed a lineage of lobe-finned fishes into the earliest land vertebrates. She was widely regarded as the
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world leader in this field. During an expedition in the summer of 1987 to the Late Devonian vertebrate localities of East Greenland, Clack collected numerous fossils of two of the earliest tetrapods, Acanthostega and Ichthyostega, which revolutionized the understanding of these animals.

**John (Phil) Grime** developed the fundamental theory in plant ecology that emerged from a lifetime of fieldwork and experimental studies in the Sheffield region, South Yorkshire, UK. His approach was an unusual combination of observation, experiment and theory: he conducted detailed, intensive observations of natural communities, alongside experimental manipulation of those communities, and simulated ‘microcosms’ in the service of formulating general rules (‘strategies’) by which plants evolve with respect to their environment.

**John Harper** carried out pioneering research on seed and seedling mortality and the ecology and control of weeds. From his base in the School of Plant Biology at Bangor, he created a new discipline: plant population biology. By integrating advances in animal population biology and evolution into his own work, he helped to create a complete master discipline of ecology, reflected in a textbook for which he received an exceptional lifetime achievement award from the British Ecological Society.

**Hubert (Jim) Markl** was a zoologist and animal behavioural physiologist. He was arguably the most influential figure in European science policy. Uniquely, he served as president of the Deutsche Forschungsgemeinschaft and the Max Planck Gesellschaft. In these roles he was an outstanding and bold advocate for scientific research in Germany and throughout Europe. He was also a leading spokesperson in Germany on contested issues at the interface between science and society. He strove to expose fully, and acknowledge, the Max Planck Society’s responsibility for atrocities committed by the Kaiser Wilhelm Gesellschaft scientists during the Nazi era.

**Robert May (Lord Robert May of Oxford)** was the leading theoretical ecologist of his generation. His mathematical analysis of the stability of ecological communities challenged orthodox views and spawned a new research agenda. He demonstrated that many different patterns of population fluctuations, including chaotic behaviour, could arise from simple mathematical models. All his work was characterized by his remarkable ability to reduce complex problems to their essential simplicities. He served as the UK government’s chief scientific advisor between 1995 and 2000, and as President of the Royal Society between 2000 and 2005.

**Colin Pennycuick** was almost single-handedly responsible for the successful, and continuing, merger of the engineering and mathematical sciences of aerodynamics and flight mechanics with ornithology, ecology and bird flight behaviour. He pioneered the use of small aircraft and powered and unpowered gliders to follow soaring and migrating birds in their natural environment, exploiting his top-level pilot skills. He also invented, designed and built novel instrumentation for making hitherto unheard-of laboratory and field measurements.

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**Engineering**

**Peter Clarricoats** made fundamental contributions as a microwave engineer to the fields of applied electromagnetics for microwave and optical waveguides and microwave antenna feeds. He was also a pioneer of optical fibres, establishing the theory of electromagnetic
propagation in dielectric and ferrite structures. He discovered that such structures can, under some conditions, support ‘backward waves’ and that guides can propagate complex modes. He published what became standard reference texts on corrugated horns for microwave antennas, microwave horns and feeds.

**Eric Mansfield** was a structural engineer who worked at the Royal Aircraft Establishment Farnborough. His main working tool was the mathematical theory of elasticity, which he deployed with skill, ingenuity, perseverance and imagination to investigate the many problems related to the design of aircraft structures during a period of development of higher flight performance and new materials. He developed the novel and powerful tension field theory for understanding the post-buckling behaviour of thin webs in shear, and the analogous inextensional bending theory of thin wings.

**Sir Edward Warner** was at the forefront in developing health, safety, risk assessment and environmental policies, particularly in their implementation to chemical process plants. He was appointed court expert to the Court of Enquiry following the Flixborough explosion in 1974. As treasurer of the Scientific Committee on Problems of the Environment, he chaired three of its major projects: Environmental Consequences of Nuclear War; Pathways of Artificial Radionucleotides; and Radiation from Nuclear Test Explosions. He led the first international team to Chernobyl after the reactor meltdown in 1986.

**Health and sustainable development**

**Coluthur Gopalan** devoted his career to the investigation and mitigation of the nutrition-related problems of Indians, especially those of the disadvantaged sectors. His studies showed that, contrary to the global belief, both kwashiorkor and marasmus were manifestations of protein energy malnutrition. His research studies on improving the nutritional status of pregnant women and children with food supplementation led to the initiation of India’s Integrated Child Development Scheme and Mid-day Meal programmes. India’s National Anaemia Prophylaxis Programme and Massive Dose Vitamin A Supplementation Programme were also initiated on the basis of the studies he led.

**Calestous Juma** was an internationally recognized authority and leader in the application of science, engineering and innovation to sustainable development in developing and developed countries. His continuing original work focused on analysing the co-evolution of technological innovation and institutional change in socioeconomic systems. He ran programmes that advanced science, technology and innovation policy research, especially biotechnology, provided high-level science and technology advice and promoted the conservation of biological diversity.

**ACKNOWLEDGEMENTS**

As usual, let me begin by repeating our gratitude to the authors of the memoirs for their outstanding work in writing biographies of lasting value, particularly during another 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. 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.
We must also thank Tom Lowen, the production manager for *Biographical Memoirs* for his outstanding work on the memoirs over the last three years and wish him success as he moves to new pastures. It is also a pleasure to acknowledge the efforts of the Editorial Board, who have been very helpful indeed by suggesting memoir writers, helping with refereeing and keeping a sharp eye on all aspects of the evolution of *Biographical Memoirs*. Often, they go far beyond the call of duty in ensuring that the memoirs are of outstanding quality.

**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.

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 2020. He is currently working on the third edition of his book *Galaxy formation*. He has continued to enhance the online digital archive of historic photographs illustrating the history of the Cavendish Laboratory. A major task is preparing for the move of the Cavendish Collection of Historical Scientific Instruments to the new Cavendish Laboratory in 2023.