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ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY[1]

By Sir HENRY DALE, C.B.E.

FULLERIAN PROFESSOR AND DIRECTOR OF THE LABORATORIES OF THE ROYAL INSTITUTION, LONDON

We are to-day within a few weeks of the three hundredth anniversary of the birth of Isaac Newton. Wherever the progress of our Western science and philosophy has become effective, men will remember what that event was to mean for the world. Newton, as we shall hear, at the age of forty-three, when he had determined to abandon all further concern with natural philosophy, was induced at length, by Halley's friendly insistence, to give written form and system to the mathematical discoveries with which his amazing mind had been occupied over a period of some twenty years. The result was one of the greatest intellectual achievements in the history of mankind—the "Principia," providing for more than two centuries a framework for the mechanical interpretation of the universe and a basis for the building of physical science, and therewith of the material structure of our modern civilization.

We in Britain regard Isaac Newton as still, beyond challenge, the greatest of our men of science. Nor should the claim be limited to this island or to the British commonwealth of nations; for it was not till nearly half a century after Newton's death that former British colonists in North America began their development of an independent nation; and Newton is theirs as well as ours.

But, while we may proudly claim him as the countryman of all who share the birthright of the English tongue, the discoveries of science have belonged, and must belong again, to the whole world, and Newton's achievement is a part of the common heritage of all peoples. It can not be doubted that, if it had fallen in normal times, this tercentenary would have been

[1] Anniversary meeting, November 30, 1942.

marked by the greatest of international gatherings, in which men of science and philosophers from all the world would have assembled to do honor to Newton's memory. It would have been natural then to expect leadership, in such an enterprise, from the only two institutions which were intimately concerned with Newton's career as a man of science—Trinity College, in Cambridge, and this our Royal Society of London. Our two foundations did, indeed, confer as to the wisdom of attempting by joint action, even in this year of war, to arrange such a restricted and domestic celebration as the present conditions would allow. We agreed, however, to put aside such planning for the present, carrying it forward in our hopes to the time when a world at peace may be able to join in international commemoration of an event which has meant so much for all mankind. May the time be not too far distant.

To-day we are holding the two hundred and eightieth anniversary meeting of the Royal Society, on Saint Andrew's Day as by regular custom, ever since the first meeting on that day in 1662. It seemed to us that we should depart, on this occasion, a little from the usual order of our proceedings, so that, on a day so near to the tercentenary of his birth, our Fellows and our guests may be reminded of Newton. We have accordingly asked three of our Fellows to address the society on different aspects of Newton's work, in its relations to the science of the past and the present. We have asked Professor Andrade to give us the opportunity of understanding the magnitude of the change which Newton's work produced, in the conceptions of the material universe which were current in his own times. We know that to his contemporaries Newton's discoveries came as a great revelation, and we hope that Professor Andrade will help us to understand why they did so. We have asked Lord Rayleigh to deal, by demonstration where possible, with the experimental work of Newton and the great discoveries which he made by that method. This is an aspect of his greatness which popular estimates have tended to overlook; but I think that Lord Rayleigh will be able to convince us that Newton as an experimenter would have had claims to a place among our greatest men of science, even if he had failed, as he so nearly did fail, to write the "Principia." And, finally, we have asked Sir James Jeans to give us some reassessment of the validity and permanence of Newton's system, in relation to the immense advances of knowledge in our own times. There are many who have not the mathematical equipment to follow them in detail, who are nevertheless aware that revolutionary changes have been taking place in conceptions of the mechanics of the universe and of its ultimate material units. How is the Newtonian system affected by the discoveries which have required the general theory of relativity and the quantum mechanics at opposite ends of the stupendous scale? Is it being supplemented, modified or superseded after its centuries of dominance? We hope that Sir James Jeans will tell us; and we may remember, perhaps with comfort, that Newton's "Principia" seemed difficult and abstruse to his contemporaries, and that he even confessed that he had made it so deliberately, "to avoid being bated by little smatterers in mathematics."

Before I call on our chosen lecturers to address us, there are two other matters relating to Newton and the Royal Society, which it seems proper to mention here. In the hamlet of Woolsthorpe, near Colsterworth on the Great North Road, some six miles south of Grantham, there is still a modest manor farm-house, with a small orchard in front of it. Here the Newtons lived, simple yeoman farmers, and here, two months after his father had died, Isaac Newton was born, a puny, premature infant, on Christmas day, 1642, twenty years before the Royal Society was incorporated by the grant of its first charter. The house stands but little altered since that day. The room in which Newton was born has a simple marble tablet on the wall, inscribed with Pope's well-known couplet. But this house had importance in Newton's later life and in his work, and not only as his birthplace. It was here that he returned from his schooling at Grantham, at the age of sixteen, to take charge of the farm for his mother; and here, to the incalculable gain of science and the world, he showed such incompetence as a farmer that he was sent back to school, and thence to Cambridge. It was here, again, that he returned in the autumn of 1665, when the plague drove him from Cambridge; and here, during the following eighteen months of quiet exile in the country, his early ripening genius grasped already the essential principles of his major theoretical discoveries. You can still see the upper chamber which he then used as a study; and in the little orchard there is an old, recumbent apple tree, which, they will tell you, is descended by direct grafting from that which Newton saw. The land which Newton's family farmed is rapidly being laid waste, alas, by quarrying for ironstone; and soon there will be little left unspoiled save the orchard and garden round the house. It has seemed to us that, in this year of commemoration, something should be done to preserve for posterity a house and garden which carry such momentous memories, and which have meant so much for science. We have accordingly formed a small committee, in which Sir John Russell and Sir James Jeans have joined with the officers of the Royal Society; and we are in negotiation with the lord of the manor as to the possibility of acquiring this now tiny but historic property, so that it may be put for as long as possible beyond the risk of damage or decay.

Then I think that it is our special duty here, at this anniversary meeting, to remember that, while Newton's great discoveries belong to the world, they came to publication through the Royal Society, and that Newton occupied its presidential chair for the last twenty-four years of his long life. Though his "Optiks" was not published till after he had become president, his original work for science was practically finished by the time of his election, and he had for some years been master of the Mint. There can be no doubt, however, that the wide fame of his achievements, and the respect and admiration in which he was everywhere held, did much, at a critical period in its history, to establish the prestige of this society in the eyes of the world. Let us then remember to-day that Isaac Newton, the greatest man of science of our race, was also the greatest of the Royal Society's presidents.

AWARD OF MEDALS, 1942

The Copley Medal is awarded to Sir Robert Robinson. He is recognized in all countries as one of the world's leaders in organic chemistry, and is one of the greatest and most versatile of investigators in that department of science. His researches, with a long and notable succession of pupils and collaborators, have covered a remarkably wide range of problems in this field, and his approach to these have been distinguished by brilliance in conception and a genius for the selection of methods leading to the desired solutions.

Robinson's investigations have been particularly concerned with the chemistry of natural substances, products of the life processes of plants and animals. His work has thus been a potent factor in the tendency of organic chemistry to return, in recent years, to an objective nearer to that of its origin, and to make contacts of growing intimacy and value with biochemistry, a more recent development in response to the stimulus of functional biology.

This occasion does not permit any attempt at a complete or detailed survey of all the different fields which Robinson's work has illuminated and opened to further exploration. Special mention must be made, however, of his long series of fundamental investigations on the constitution and relationships of the plant alkaloids. His theory of the biogenesis of plant products seems rather to have inspired than to have resulted from his own early and elegant synthesis of tropinone; and it has revealed an unforeseen and coherent relationship between the constitutions of different groups of alkaloids, and given a great stimulus to work on their synthesis. The work published from Robinson's laboratory has been fundamental to understanding of the isoquinoline and the indole series of alkaloids, of morphine and its allies, and of the structural formulae of strychnine and brucine, which formed the subject of his Bakerian Lecture.

Of at least equal scientific rank is the work which Robinson carried out and inspired over many years on the anthocyanin and, more recently, on the anthoxanthin pigments of plants, culminating in the synthesis of the actual coloring matters of flowers, and forming as a whole one of the most brilliant achievements in the whole range of modern organic chemistry.

Robinson's mastery of synthetic resources, and his penetrating instinct for clues to organic constitution, have been further demonstrated in a more recent approach to the synthesis of the steroids, in the production of series of compounds of interest for chemotherapy, and in notable studies of individual natural substances of a range of other types. He is, moreover, a philosopher as well as a master of experimental possibilities; and his theory of organic reactions, in the modern, electronic terms of valency bonds, has had a great influence on the development of fundamental conceptions in organic chemistry.

The Copley Medal is the highest recognition of scientific achievement in the Royal Society's gift, with no limitations of subject or nation; and the society may well find cause for satisfaction in the knowledge that the award of its premier medal for achievement in organic chemistry, after an interval of many years, finds among its own Fellows a recipient of such unquestioned preeminence as Sir Robert Robinson.

The Rumford Medal is awarded to Dr. G. M. B. Dobson. The Rumford Medal awarded by the Royal Society was established for the recognition of important discoveries made in Europe, especially on heat or on light. These conditions appear to be met with a special fitness in the award of the medal this year to Dr. G. M. B. Dobson, for his meteorological researches and discoveries. For Dobson's work has, in recent years, greatly extended knowledge of the linkage between the behavior of ozone and cyclonic disturbances, in that complicated heat engine which is the earth's atmosphere; while light may be said to have provided the basis of measurement for Dobson's spectrographic studies of the distribution of ozone, in time and in height above the earth's surface. Light had also a major concern in earlier researches on meteors in which Dobson collaborated with Professor Lindemann (now Lord Cherwell); in these, the study of the heights between which meteors become luminescent enabled them to draw conclusions as to the density, and from these as to the temperature of the atmosphere at great heights from the earth's surface. But it is especially on Dr. Dobson's own studies of the ozone of the atmosphere, continued over many years and producing results of outstanding importance for meteorology, that the award is based.

A Royal Medal is awarded to Professor W. N. Haworth, a brilliant leader in organic chemistry. Haworth's great claim to distinction arises from the revolutionary change which has been produced by his own investigations, and by those of his immediate pupils, in the whole aspect of an important section of organic chemistry, dealing with the structure and the relationships of the carbohydrates. The ring structure of the simple sugars, first proposed by Tollens and supported by the work and the authority of Emil Fischer, had been generally regarded by chemists as firmly established. Detecting insecurities in the arguments which led to this formulation, Haworth developed the methylation technique, first used by Purdie and Irvine, and applied it systematically to the monosaccharides. He was thus able to show, by unequivocal methods of organic chemistry, that the accepted ring structure of these sugars was incorrect, and that, in their normal and reactive forms, they were derivatives of pyran and of furan, respectively.

Later Haworth further developed his methods in application to sugars and carbohydrates of increasing complexity. By his work, and that of others who have followed his lead, the detailed structures of many disaccharides and of some trisaccharides have been established. Progress has further been made in his attack on the structural complexities of the polysaccharides, and a simple chemical method has been evolved for determining their minimal molecular weights. Professor Haworth's work, in the field which he has thus made his own, has received the high international recognition of a Nobel Prize, and will assuredly take rank as a major achievement of permanent significance in chemical history.

A Royal Medal is awarded to Dr. W. W. C. Topley, who is one of the most distinguished of the British bacteriologists of recent years. The most important of Topley's contributions to bacteriology and experimental medicine has been the experimental study of epidemics, which he initiated and of which the methods have been largely his own creation. Much had been learned by the statistical analysis of observational data, dealing with the origin, spread and development of natural epidemics, under conditions largely out of control. Topley conceived the idea of applying such methods to the investigation of epidemics started artificially in populations of healthy mice, kept in the laboratory under conditions which could be exactly controlled and deliberately varied. Thus the factors conducive to the rise, culmination and decline of an epidemic, to its revival or its final subsidence, could be experimentally determined. In a long series of such studies, the important results of which were reviewed in his Croonian Lecture for 1941 on "The Biology of Epidemics," Topley had the statistical cooperation of Professor Major Greenwood, in both planning and interpretation.

On this firm basis of knowledge concerning the incidence and mortality of a naturally transmitted infection in untreated stock, the efficiency of prophylactic measures could be put to a controlled test. Under Topley's guidance and inspiration, accordingly, substantial progress had been made by his chemical colleagues towards the isolation from various species of pathogenic bacteria of highly purified and stable antigens, and the practical trial of some of these was interrupted by the outbreak of war.

Dr. Topley's researches have had a great and lasting influence on the study of bacteriology, immunology and epidemiology in relation to human medicine. His recent change of the focus of his interests may be expected to give an important stimulus to advance in many cognate fields of agricultural research.

The Davy Medal is awarded to Professor C. N. Hinshelwood for his work on the kinetics of chemical change, characterized by its pioneering quality and by the varied new lines of research which it has opened up. An experimental investigator of great skill and achievement, Hinshelwood has also enlarged the theory of the subject by able mathematical analyses and descriptions based on the concepts of collisions and of activation energy.

Hinshelwood took a leading part in the early study of homogeneous gaseous reactions. As the result of the examination of a number of bimolecular examples he was able to show, with reason, that these are confined to molecules containing few atoms, and that the actual rate was given by the product of the total collision rate and the probability of a molecule possessing the experimental energy of activation. Unimolecular reactions were found to occur with polyatomic molecules and to show more complex features. In association with Professor Lindemann (now Lord Cherwell), Hinshelwood put forward the mechanism, now accepted, whereby a reaction fundamentally dependent on collisions may nevertheless have unimolecular kinetics. This theory he was able to verify by showing that the rates of such reactions diminish at low pressures and that the kinetics then become bimolecular.

In the field of chain reactions Hinshelwood opened up new lines of advance by studying the thermal reaction between hydrogen and oxygen. Thus he discovered, and offered clear explanations for, the curious phenomenon of "explosion limits," confining explosive reaction, at any fixed temperature, sharply to a particular pressure region. Elaborate studies of the effects of nitrogen peroxide and other foreign gases on the hydrogen-oxygen reaction brought to light the very great kinetic complexities of an apparently simple type of chemical change. In this work Hinshelwood drew attention to the influence of the container surfaces on chain reactions, and also clarified the confusion of evidence concerning the effects on reaction rates of the intensive drying of gases. He discovered the inhibition of certain gaseous reactions by nitric oxide and interpreted the effect as due to the removal of radicals from, and the suppression of, "chains."

Hinshelwood has also carried out a large number of experiments on heterogeneous reactions and shown that their differences in kinetic behavior can be explained by the application of the concepts of Langmuir.

Throughout all these researches, carried out with the utmost economy and directness, though with full experimental precautions, and interpreted in the most lucid manner, Hinshelwood has never lost sight of the essential complexity of chemical reaction mechanisms. He has always been ready to modify his views in accordance with new experimental evidence and to make the fullest use of the more recent developments of wave-mechanics and of statistical mechanics. Summarized by their author in two well-known treatises, Professor Hinshelwood's distinguished researches furnish abundant ground for the award to him of the Davy Medal.

The Darwin Medal is awarded to Professor D. M. S. Watson, preeminent among paleontologists for his contributions to knowledge of the course of vertebrate evolution. His researches have been concerned mostly with the origin of the land vertebrates, with the fishes most nearly related to them and with the main line of evolution leading to the mammals.

It will not be possible on this occasion to survey Watson's work in all its aspects, and mention must be restricted to some of the major lines of advance which it has opened. His Croonian Lecture, in 1925, summarized the conclusions which he had reached by that date as to the evolution of the Amphibia, demonstrating for the first time the relationship of the Stegocephalia to the Osteolepid fishes.

In addition to tracing the descent of land vertebrates thus from Amphibia back to fishes, Watson followed the line of the evolution of the mammals, through early, primitive reptiles, the Cotylosaurs, to the mammal-like reptiles, in a large series of valuable papers. He related this work on the reptiles to that on the amphibians in a paper on the evolution of the shoulder girdle of the Tetrapoda.

In this work on the fossil vertebrates, in its relation to the course of evolution, Watson has not confined his attention to morphological details, but, with an enterprise remarkable in a paleontologist though characteristic of his outlook, has considered where possible the functional significance of the structures preserved in the rocks; as in the paper in which he considers the mode of action of the shoulder girdle and deduces the nature of the musculature of a group of marine fossil reptiles.

Pursuing his study of mammalian origins, Watson was led to study the most primitive of living mammals, the oviparous Monotremes, and to discover that characters in which their skulls differ from those of other mammals can be regarded as extreme developments of features observed in the skulls of certain fossil, mammal-like reptiles.

Watson's work has continued in full vigor into recent years, and has brought two further contributions of major importance to the study of evolution in the vertebrates. One is concerned with the origin of the frogs from more primitive amphibian types, while the other shows that a group of fishes from the Old Red Sandstone constitute a separate class of vertebrates, equal in rank to and ancestral to the remaining fishes.

Tracing, in this brilliant series of researches, the main stages of the descent of the mammals from their earliest fish-like ancestry, Professor Watson has certainly performed "work of acknowledged distinction in the field in which Charles Darwin himself labored."

The Buchanan Medal is awarded to Sir Wilson Jameson, formerly dean of the London School of Hygiene and Tropical Medicine and since 1940 the chief medical officer to the Ministry of Health and the Board of Education. In both capacities Jameson has shown himself to be a man of stimulating influence and leadership, determined and persistent in his efforts to ensure that advances of medical knowledge in the laboratory, the clinic and the field shall receive prompt application in administrative practice.

Largely to Jameson's vigorous policy is due the hope that active immunization against diphtheria, which has banished the disease from many large communities of North America, will at length find systematic and effective application in this country, where many of the discoveries were made which have rendered it safe and practicable. In the prompt official adoption of methods using modern technical resources, to deal with the recent increase of tuberculosis under war conditions, and in the recognition of adequate and scientifically planned nutrition of the people as a central item of an effective health policy, Jameson's active and enlightened influence can again be discerned.

Of the grounds on which the founder of the Buchanan Medal desired the awards of it to be made, Sir Wilson Jameson's high claim to it is based on "administrative and constructive work" of outstanding merit in the service of hygienic science.

The Hughes Medal is awarded to Professor Enrico Fermi, now of New York. Professor Fermi has made most notable contributions both to theoretical and experimental physics. In the early days of the modern quantum theory he was one of the first theoretical physicists to appreciate the generality of the considerations put forward by Pauli and known as the exclusion principle. This led him to discuss the statistical theory of a perfect gas of particles in equilibrium, obeying this principle, with results which were obtained independently and almost simultaneously by Dirac by similar methods. These results of Fermi and Dirac are of the utmost importance in the modern theory of assemblies of similar particles, such as electrons, protons and neutrons. Following this outstanding personal contribution, Fermi played a great part in building up at Rome a distinguished school of theoretical physics, where he himself made one of the earliest successful attempts to construct a theory of radioactive β-ray change. This theory shows the most profound insight into the theoretical nature of the quantum theory.

His interest in the atomic nucleus led Fermi naturally on to his experimental studies in this field. Immediately after the discovery of the neutron he realized that it provided a new possibility of attack on the nucleus and of stimulating nuclear change by neutron bombardment. This work opened up the fruitful modern field of study concerned with the transformations of nuclei of medium and great atomic number, and led directly to the most exciting transformations of all, the nuclear fission of uranium and thorium.

Professor Fermi's work is characterized throughout by profound insight and great experimental skill. In the fields which he has made his own he is universally acclaimed a leader.

CRISIS IN RUBBER[1]

By JOHN L. COLLYER

PRESIDENT, THE B. F. GOODRICH COMPANY

It is a pleasure for me to meet with members of the Academy of Political Science. I feel honored and privileged to acquaint you with certain facts pertaining to the all-important question of rubber—natural and man-made.

America is in the grip of a rubber crisis. Our country, which normally uses more than half of all the rubber that is consumed throughout the world, has been shut off by decisive enemy action from sources which formerly produced 90 per cent. of the world's rubber. We are now engaged in a grim race against time. Several hundred thousand tons of new rubber will shortly be urgently needed to manufacture the wide range of war products required by the armed forces of the United Nations and to keep our vital industrial plants and essential transportation functioning.

The crisis that we face resolves itself into a question of whether we can bridge the gap until synthetic rubber manufacturing facilities now under construction within our country's borders are producing the huge quantities of this indispensable material that we will need to win the war.

It seems odd that we should be faced with a crisis in rubber when we stop to consider that rubber originated right next door to us in South America where native or wild rubber trees are situated. The seeds from which the extensive Eastern plantations have sprung were collected in South America in 1876. But by 1900, no more than 10,000 acres have been planted in the East.

The rubber plantations of the world now covering a planted area of approximately 9,000,000 acres have had in 1941 a productive capacity of 1,600,000 tons a year. The world's consumption in 1939 through 1941—a record three-year period—was at the rate of about 1,100,000 tons a year, which left a potential surplus of 50 per cent.

It has been my privilege to have visited the Eastern plantations and to have witnessed rubber manufacturing in most parts of the world, including Germany and Japan. In the course of many visits to Germany during the 1930's, I observed at close range the development of an imposing synthetic rubber industry as the Nazis prepared for war that is now resulting in the greatest death and destruction known to mankind.

During the war of 1914–1918, Germany had an inferior synthetic rubber. Research and development work—started at that time—has been diligently continued and intensified ever since. To-day Germany is probably living at least 75 per cent. on synthetic rubber.

Based on what I learned in Germany and Japan

[1] Read before the Academy of Political Science, New York, November 10, 1942.