

electromagnetic waves from moving conductors, the propagation of light in crystals, and general properties of the partial differential equations of physics: in 1904 he made notable advances in the study of fields of force due to moving electrons. These researches led him naturally to the question of the origin of spectra. At that time (some years before Rutherford's discovery of 1911 that the atom is like a miniature solar system, or Bohr's discovery of 1913 that a spectral line is generated when an electron falls from one orbit to another), it was generally supposed that spectra were produced in the same way as sounds are produced by the free vibrations of a material body: that is to say, the atom was regarded as an electrical system of some kind, which had a large number of natural periods of oscillation, corresponding to the aggregate of its spectral lines. Conway, in a paper of only two and a half pages in the *Scientific Proceedings of the Royal Dublin Society* in 1907; was the first to break with this conception, and to enunciate the principles on which the true explanation was to be based: namely, that the spectrum of an atom does not represent the free vibrations of the atom as a whole, but that an atom produces spectral lines one at a time, so that the production of the complete spectrum depends on the presence of a vast number of atoms. In his view an atom, in order to be able to generate a spectral line, must be in an abnormal or disturbed state; and in this abnormal state, a single electron, situated within the atom, is stimulated to produce vibrations of the frequency corresponding to the spectral line in question. The abnormal state of the atom does not endure permanently, but lasts for a time sufficient to enable the active electron to emit a fairly long train of vibrations.

As compared with Bohr's paper of six years later, Conway's work falls short in two respects: first, he associated the spectral line with a single state of the atom, whereas Bohr associated it with the transition between two states; it should, however, be remembered that Conway wrote before Ritz's paper of 1908 had convinced spectroscopists that the frequency of a spectral line is the difference of two 'terms'. Secondly, he did not connect the phenomenon with Planck's quantum of action. For these reasons, Conway's theory did not prove immediately fruitful, as Bohr's did; but the very revolutionary general principles he suggested were perfectly sound, and show a remarkable physical insight.

Conway was probably the most accomplished living manipulator of the quaternion calculus: and in a number of his later papers, he showed its superiority for the formulation both of special relativity and of quantum mechanics. He had a personal devotion to the memory of its discoverer: and had a chief share in persuading the Royal Irish Academy to undertake the publication of a collected edition of Hamilton's works. For the two sumptuous volumes which have so far appeared, and which contain a great amount of matter hitherto unknown, he acted as chief editor.

Conway held the chair of mathematical physics in University College, Dublin, until 1940, when he was elected president of the College, a position from which he finally retired in 1947. He was elected a fellow of the Royal Society in 1915, and served on its Council during 1935-36; he was for terms of years president of the Royal Irish Academy and of the Royal Dublin Society, vice-chancellor of the National University, and chairman of the School of Theoretical

Physics in the Dublin Institute of Advanced Studies. He was an honorary fellow of Corpus Christi College, Oxford, and received honorary degrees from the Universities of St. Andrews, Dublin, and the Royal University of Ireland. In 1939 he was appointed a member of the Pontifical Academy of Sciences.

His wife predeceased him; but he is survived by his son and three daughters.

EDMUND WHITTAKER

Dr. L. O. Howard

LELAND OSSIAN HOWARD, who died on May 1 at the age of ninety-two, was a well-known American biologist, administrator and writer, and chief of the Bureau of Entomology of the U.S. Department of Agriculture for thirty-three years. He was born on July 11, 1857, at Rockford, Illinois, and was the eldest child of Ossian Gregory Howard and his wife Lucy Dunham (Turber) Howard, of the famous Pickering family of Massachusetts from whom there also came several other men of science. He was also distantly related to Senator Jacob M. Howard, of Michigan, one of the founders of the Republican Party in the United States, and to William Howard Taft, ex-president of the United States. While still in his infancy his parents removed to Ithaca, New York. He early became interested in outdoor life and natural history, and particularly in the birds and insects. In 1873 he entered Cornell University, and, during the four years that followed, he not only made excellent progress with his studies, but also was particularly fortunate to come under the influence of some outstanding men of science, notably John Henry Comstock, S. H. Gage and the elder Agassiz, whose lectures he had the good fortune at times to attend. Perhaps most important of all, however, he came to know Prof. C. V. Riley. Riley succeeded Towend Glover as entomologist of the Federal Government, and on the recommendation of Prof. Comstock he appointed young Howard, then newly graduated from Cornell at the age of twenty-one, to be his assistant. This was the humble beginning, on November 13, 1878, of a period of Government service that continued for more than forty-nine years. In due course he was assigned to preparation of a manual on silk culture. This formed the beginning of a long series of publications that were issued year after year prepared by Howard and published under name of his chief—a practice not uncommon in those days.

Howard, when thirty-seven, was appointed chief of the Division of Entomology. It is of significance to note that when he became chief the total annual appropriation for Federal entomological work of all kinds was only 30,000 dollars; when he retired, thirty-three years later, in 1927, at the age of seventy, the annual appropriation was 3,000,000 dollars. During the ten-year period that followed from 1894 to 1904, there occurred three events that fixed the attention of the whole country upon the importance of entomological work: the first of these was the discovery of the gypsy moth in Massachusetts in 1889; the second was the discovery of the San José scale in the United States in 1893; and the third was the discovery of the Mexican cotton boll weevil in Texas in 1894. The research work performed on these problems was in addition to that on other insect pests previously being studied, and obviously required considerable additional funds and increased

personnel, and these resulted in substantial growth of every phase of the organisation. In 1904 there was put into effect by Congress the plan of organisation of Federal entomological work by which separate units were established for investigation of pests affecting the various host plants, namely, field crops, fruits, truck crops, forest- and shade-tree insects, and the like. With various modifications, changes and additions made necessary over the years, essentially the same general set-up remains in effect at the present time in the Bureau. It was also on July 1, 1904, that the entomological work of the Department was raised to Bureau status.

A notable addition to the striking events of the last decade of the nineteenth century was the discovery by Ross in 1898 of the carriage of malaria by *Anopheles* mosquitoes. As a result of this and other discoveries, medical entomology became a most important field of investigation and demanded the

intimate co-operation of pathologists and entomologists, and in all these Dr. Howard played an honourable part.

From 1896 until 1930 Dr. Howard was recognized by being given degrees from several institutions. These included the Ph.D., M.D., LL.D. and D.Sc. More than nine hundred publications came from the pen of Dr. Howard during his creative years, including not only his official reports and bulletins and a veritable stream of periodical articles, but also several books, notably "The Insect Book", 1901; "Mosquitoes", 1901; "The House Fly", 1911; "Mosquitoes of North America", 1912-17 (four vols., joint authorship with H. G. Dyar and Frederick Knab); "History of Applied Entomology", 1930; "The Insect Menace", 1931; and "Fighting the Insects: an Autobiography", 1933. In addition to all this, many home and foreign honours were conferred upon him.

J. S. WADE

NEWS and VIEWS

Commonwealth Viticultural Research Station, Merbein, Victoria

MR. FRANK PENMAN, chief irrigation officer of the State Rivers and Water Supply Commission of Victoria, has been appointed to the Commonwealth Viticultural Research Station, Merbein, and will succeed the present officer-in-charge, Mr. A. V. Lyon, when the latter reaches the retiring age shortly. Mr. Penman holds the degree of M.Sc. of the University of Melbourne, and is a fellow of the Royal Australian Chemical Institute. He has had very considerable experience in research into problems of soils and irrigation, especially in relation to vine and citrus culture, and was for many years an officer of the Department of Agriculture, Victoria.

Mr. Lyon has been in charge of the work of the Station since it was first started by the Mildura and District Research Committee in 1919. He continued in that position when the Station was taken over by the Council for Scientific and Industrial Research in 1927. The work of the Station has contributed towards the major advances that have been made in the viticultural industry of the region since the First World War. Mr. Lyon has also made a notable contribution in providing personal detailed advice to the settlers during the critical years of many irrigation settlements along the Murray.

Economics of the Family

PUBLICATION of the Report of the Royal Commission on Population has been followed by a series of papers, and the fifth volume, entitled "Memoranda Presented to the Royal Commission" (pp. 120; London: H.M. Stationery Office, 1950; 3s. net), which has recently been published, contains an important contribution on "The Economic Position of the Family", by Mr. J. Hajnal and Prof. A. M. Henderson. The authors of this paper, after discussing the various ways in which parents meet the extra cost of bringing up children, by comparing their expenditure with that of childless couples having the same income, conclude, first, that at all income-levels parents have to make considerable economic sacrifices to maintain their children, and, secondly, that children in large families have a lower standard of living than children

in smaller families. Even at relatively high income-levels, parents meet a large proportion of the cost of their children by reducing their own expenditure on necessities (for example, clothing) and buying cheaper kinds of goods to satisfy their requirements (for example, food). The cost of children is not met only by spending less on luxuries. The economic position of the family has been considerably affected by the changes of conditions since 1938. It would seem that, despite the large increase of prices and incomes, the actual money cost of a child to its parents, at a low working-class level of income, is substantially unchanged as compared with the pre-war figure. The burden of two children, which at this income-level was about a third of a childless couple's income, has now fallen to one-sixth. The raising of the school-leaving age, however, has meant that the burden lasts a year longer. Other papers in this volume include several on "The Relation between Intelligence and Fertility", by Sir Godfrey Thomson and other contributors, and a special memorandum submitted by Mr. R. F. Harrod in which he advocates family endowments proportionate to income through compulsory insurance.

National Forest Park of Glen Trool

THE latest of the National Forest Park Guides (H.M. Stationery Office; 3s.) describes the 110,000 acres which comprise the five forests, Glen Trool, Carrick, Cairn Edward, Changue and Kirrough-tree which the Forestry Commissioners have grouped to form the National Forest Park of Glen Trool. All these forests are places of great natural beauty, and it is gratifying to know that several proprietors and tenants of lands in the vicinity of the Forest Park have agreed to allow walkers to use fixed routes across their properties. These routes are indicated in the map that accompanies the guide-book, which also contains articles on the mountains, lochs and rivers by H. L. Edlin; geology by Prof. G. H. J. Daysh; plant life by Prof. J. R. Matthews; and wild animals and birds by Gavin Maxwell. J. R. Thom, conservator of forests for South Scotland Forestry Commission, describes the forests and plantations, and Andrew McCormick gives details of