Lord Avebury (1834–1913)

THE centenary of the birth of Sir John Lubbock, afterwards Lord Avebury, occurs on April 30, and the occasion should not be allowed to pass without grateful tribute to his memory. It is perhaps difficult for the younger generation to realise the distinguished position which that great Victorian held in the scientific world of his day. In the present era of specialisation many may underrate the claims to greatness of one who was an amateur naturalist and a popular writer. But a more careful consideration of his work and aims will show that he helped to lay those foundations of science and scientific education which has given the present generation of professional scientific workers the opportunities they now enjoy.

We must remember that in the days when science was not included in the ordinary school curriculum, and was a negligible part of a university education, the advance of science was largely due to the work of amateurs, such as Charles Darwin, Sir John Lubbock the banker, Sir Joseph Prestwich the wine-merchant, and Sir John Evans, a paper manufacturer. Not that there was anything amateurish in the work of these pioneers. They were capable of intensive and fundamental researches, and Lord Avebury's "Monograph on the Collembola and Thysanura", published by the Ray Society, is sufficient proof of his capacity for thorough and detailed investigation, and will remain an authoritative and standard account of these groups of insects. It was the wideness of his interests, and not any lack of thoroughness, which both prevented Lord Avebury from continuing his researches in one branch of science and at the same time caused him to become an all-round naturalist of remarkable attainments.

Lord Avebury's love of natural history dated from his infancy, and his mother, who for many years charged herself with his education, noted in her diary that his taste for natural history made him an acute observer. His father, an able mathematician and a fellow of the Royal Society, took an equally careful share in the early education of his son, and when the latter was at Eton repeatedly urged the authorities to include some science in the curriculum. Both parents had very definite views on education, and dissatisfied with John's progress at Eton, he was withdrawn at the early age of fourteen and a half and at fifteen years of age began life in the family bank, of which he became afterwards the head. But in spite of the exacting commercial duties, by working early and late, throughout his long business career he devoted himself to the acquisition of new knowledge, both literary and scientific. Thus, though Lord Avebury never went to a university, he acquired a wide culture and a deep insight into Nature. Living in the country and being a keen observer he devoted himself wholeheartedly to the study of botany and entomology. His residence at Down gave him the inestimable advantage of a close personal intercourse with Darwin, who appreciated the ardent and inquiring mind of his young friend and always held him in high esteem. There is no doubt that Darwin's kindly help was a great stimulus to young Lubbock, who frequently expressed his gratitude for the inspiration he received from Darwin. That he became one of the staunchest supporters of the "Origin of Species" is not to be wondered at, and Darwin valued his support, for writing to him in 1860 he says: "I settled some time ago that I should think more of Huxley's and your opinion, from the course of your studies and from the clearness of your mind, than that of any other man in England".

It was Darwin who urged Lord Avebury's father to get his son a microscope, with the help of which his earliest researches on freshwater and marine Entomostraca and on *Daphnia* were carried out. On the strength of these investigations Lord Avebury was elected to the Royal Society in 1858 at twenty-four years of age. With the encouragement of Darwin and Huxley he commenced his investigations on insects, which he carried on for many years and which culminated, after a series of important papers, in the publication of the monograph of the Collembola already referred to, and of two books, one on "The Origin and Metamorphoses of Insects" and the other on "Ants, Bees and Wasps". His work on the senses and habits of these insects was based on definite experiments and on observations carried out for many years in succession on ants imprisoned in earth between glass plates. His own observations on the habits of insects, and the stimulus of Darwin, who was engaged in his studies of self- and cross-fertilisation of flowers, directed Lord Avebury's attention to the visits of insects to flowers, which resulted in the publication of his "British Wild Flowers considered in Relation to Insects". This was the commencement of a series of botanical books on "Flowers, Fruits and Leaves", on "Buds and Stipules", and lastly the comprehensive "Contribution to our Knowledge of Seedlings". In all three books he showed a keen insight into the morphological problems involved, and they will continue to be of the greatest help to botanical students.

Long before he had completed his entomological and botanical researches, Lord Avebury's active mind had been turned for a time into other channels, and his intimacy with Galton, Prestwich and John Evans had directed his thoughts to problems connected with the antiquity of man. A series of visits to France, Denmark and Switzerland gained him a sound and extensive knowledge of prehistoric mounds and implements which

enabled him to become one of the leaders of anthropological research in Britain, as his "Prehistoric Times" and "The Origin of Civilisation and the Primitive Condition of Man" amply testify. Anthropology, indeed, became an abiding interest with him, and he did much to preserve the destruction of prehistoric remains by introducing into Parliament the Ancient Monuments Act of 1882. It is largely due to his energy and foresight that the monumental stone circle at Avebury was preserved from further destruction, and it is characteristic of his deep interest in the latter, that when he was elevated to the peerage he took the name of Lord Avebury.

For most business men, three absorbing hobbies, including the writing in connexion with them of important books, which ran into many editions, would have been more than sufficient to occupy their time and energy, but from boyhood Lord Avebury made systematic use of his time and worked early and late to forward the aims he had set before himself. Thus, when invited to become a candidate for Parliament he accepted the invitation, much to the dismay of Darwin and Hooker. The latter wrote to Darwin: "I gnash my teeth when I think of Lubbock going into Parliament. I grudge so good a man from Science." Darwin, who had been reading Lubbock's "Prehistoric Times", wrote to congratulate him on the book, and added: "I do sincerely wish you all success in your election and in politics, but after reading this last chapter you must let me say: 'Oh dear! Oh dear! Oh dear!'"

Lord Avebury had, however, set himself several definite aims as Member of Parliament. They were: to carry a measure to prevent a rapid destruction of ancient monuments, to promote the study of science in schools, to secure some additional holidays and to shorten the hours of labour in shops. We have seen how successful he was in the first of these aims. The others he was happily destined to see eventually realised. A year after entering Parliament he was successful in getting the Bank Holidays Act. How many, we wonder, of those who have recently enjoyed the relaxation of a fine Easter Monday realise to whom they owe this boon. His warm heart for those less favourably placed than himself led him to introduce successively and successfully the Shop Hours Regulation Act of 1886, limiting the hours of labour of young persons under eighteen years of age, an Open Spaces Act, a Public Library Act and a Shop Hours (Early Closing) Act. His effort to promote the study of science in schools did not lead to the promotion of any parliamentary measure, but nevertheless his persistent agitation led to the appointment of several Royal Commissions dealing with educational problems of elementary schools, public secondary schools and the universities.

On all these Commissions Lord Avebury voiced the growing need of scientific training, and there is no doubt that many changes in this direction resulted from the evidence given and the reports of the Commissions. Particularly in relation to the Royal Commission on Scientific Instruction at the Universities, the Commission recommended substantial capital as well as annual grants towards the cost of maintenance of the universities, and the grants now given by the Treasury to the universities may be traced to the report of this Commission and to the persistent efforts of Lord Avebury. By his numerous scientific publications on anthropological, entomological and botanical subjects he did much to diffuse an understanding and love of science among the general public, and the widespread interest which he created can be gathered from the numerous editions, often reaching double figures, which were called for. His energy in this respect was ceaseless. Darwin wrote to him once: "How on earth you find time is a mystery to me". But his business had made him methodical and he knew how to economise his time. Once when remonstrated with by his family for wearing elastic-sided boots, he explained that one could learn a language in the time people took to button or lace their boots.

Lord Avebury felt driven to write and publish both his scientific and also his more popular books because of the intense enjoyment he personally got out of all his studies and of his keen desire that others should share in his pleasures. Even at home, when he had prepared a particularly good microscopic slide, he delighted to show it to the inmates of his house, including the maids and the page-boy. No one had a keener appreciation of natural surroundings, and he desired that the minds of others should be awakened to this. Hence his publication of "The Beauties of Nature" and "The Wonders of the World we live in". Similarly in "The Scenery of Switzerland" and "The Scenery of England" he explained how it was based on the geology and physical geography of these countries. Lord Avebury had also a real love of good literature, and after addressing the Working Men's College on "The Choice of Books" he published his essay on "The Hundred Best Books" which excited much interest and comment and resulted in the publication of cheap editions of many books which were out of print. His aim was ever to promote the national culture of his fellow citizens. He wanted the general public as well as the schools to enjoy a stimulating intellectual atmosphere "charged with the oxygen of science", as Sir Michael Sadler has so aptly put it. It may truthfully be said that he succeeded in a great measure in effecting this by his personal efforts. The ever-present benevolent urge combined with the simplicity and modesty of his bearing made him a most lovable character. The contentment of his life, so full of good deeds, radiated a serene charm, which was felt by all with whom he came in contact. Scientific societies and educational institutions were eager to secure his services, and he probably held a record number of presidencies of learned societies and scientific institutions.

It is not possible within the limits of an article such as this to do more than touch upon some of the activities of so many-sided a man. Happily there is a good biography of him by H. G. Hutchinson, and "The Life-Work of Lord Avebury" edited by his daughter, the Hon. Mrs. Grant Duff, contains appreciations of his work by leading authorities of the various branches of science which Lord Avebury has enriched by his researches and publications. When reading these we shall gratefully remember how much we owe to this great Victorian naturalist. F. E. W.

Stabilisation of Radio Frequencies

AMONG the problems which the rapid and extensive growth of radio communication has presented, is that of keeping the frequencies of all transmitting stations steadily at their assigned values. The success of the various international plans which have been formulated in recent years, particularly for the control of broadcasting, must ultimately depend upon the ability of radio engineers to adjust and maintain a wireless transmitting station at its correct frequency or wave-length. At the present time the primary standards of frequency, which utilise either a tuning fork or a piezo-electric crystal, are amongst the most accurate of our physical standards. With the aid of suitable equipment, there is no difficulty in maintaining and using an accuracy well within one part in a million, while the frequency standards of different countries are in substantial agreement to within a few parts in ten million. Similar types of crystal or tuning fork oscillators can be employed to control the frequency of transmitting stations of appreciable power, by the aid of somewhat elaborate power-amplifying and, if necessary, frequency-multiplying equipment. This arrangement admirably serves the purpose of those stations operating on a single wave-length, and is used with conspicuous success in broadcasting stations and those used for long-distance telegraphic and telephonic communication.

There are, however, many cases, particularly in connexion with ship and aircraft communication, where it is necessary that the transmitting station shall be able to operate on a large number of different wave-lengths and still maintain a high degree of accuracy and stability on each of these wave-lengths. It is usually an accompanying condition of such circumstances that the whole of the transmitting and frequency controlling apparatus must be much simpler than that which is employed at fixed land stations. It is to meet such a demand as this that the Radio Research Board of the Department of Scientific and Industrial Research is at present studying the problem of developing a suitable valve oscillator which will provide frequency stability at a transmitting station without the necessity for elaborate equipment.

As a preliminary to the experimental work, which is now being conducted by the Radio Department of the National Physical Laboratory, a thorough survey of the available information on the subject was made and this has recently been published*. This résumé of the literature has been drawn up in two parts. The first part consists of an essay on the subject as a whole, and comprises in effect a brief textbook of the fundamental principles of this branch of radio science illustrated by reference to typical circuit arrangements used in practice. The second part consists of abstracts of papers representative of the most important published work on the subject, with commentary notes which are intended to bring each particular contribution into perspective with the whole.

In attempting to classify the causes of frequency variations in simple valve-maintained oscillators, a distinction can be drawn between frequency variations due to changes of a purely electrical character and those due to changes of the physical configuration of the system. A simple and admittedly inadequate analysis of the valve-maintained oscillator indicates that frequency variation due to incidental changes in the valve and its circuits can be minimised by meeting certain conditions. Various special circuit arrangements have been developed on these lines and the consequent frequency stabilities obtained are variously estimated at between one and one hundred parts in a million. A more exact analysis shows that it is very difficult to maintain electrical oscillations by means of a valve without producing harmonics which have a detrimental effect upon the steadiness of the fundamental frequency. Experimental data are lacking as to the quantitative significance of this effect, which, however, may be minimised by means of circuits designed to reduce so far as possible the potential differences due to the harmonics generated. Recent investigations have shown that the inter-electrode capacitances of thermionic valves may be expected to vary with the space-charge conditions of the valve, which in turn will vary with supply-voltage and oscillation conditions. Since these inter-electrode capacitances are included in the electrical circuit which determines the frequency of oscillation, any variation in this capacitance will produce a corresponding variation in the frequency.

An ideal valve oscillator is probably one in which the frequency of oscillation is determined solely by the inductance and capacity in the external oscillatory circuit. In this case, however, it is evident that the frequency will be directly

* Department of Scientific and Industrial Research. Radio Research, Special Report No. 13: Valve Oscillators of Stable Frequency: a Critical Survey of Present Knowledge. By F. M. Colebrook. Pp. vii+56. (London: H. M Stationery Office, 1934.) 1s. net.