Address of the President, Sir Archibald Geikie, K.C.B., at the Anniversary Meeting on November 30, 1910.

The year which has passed since our last Anniversary will be memorable in our annals for the losses which death has brought upon the Royal Society. First and most conspicuous is the decease of our Patron, His revered Majesty, King Edward VII. During his brief but eminently beneficent reign, His Majesty continued to manifest the same interest in the advancement of science which he had always shown before his accession to the Throne. We mourn that a life so devoted to the cause of peace and progress should have been cut off so soon. King George V has honoured us by stepping at once into his father's place as Patron of the Royal Society, and has subscribed his name in our Charter-book. His Majesty as Prince of Wales found many occasions to show his appreciation of science, and his interest in its progress. We feel confident that under his enlightened rule the advancement of Natural Knowledge will continue to receive his support and encouragement.

The deceased Fellows are:

Dr. Ludwig Mond, died December 11, 1909.
Dr. Shelford Bidwell, died December 18, 1909.
Sir Charles Todd, died January 28, 1910.
Edward Saunders, died February 6, 1910.
Sir Robert Giffen, died April 12, 1910.
Sir William Huggins, died May 12, 1910.
John B. N. Hennessey, died May 23, 1910.
C. Greville Williams, died June 15, 1910.
The Rev. Robert Harley, died July 26, 1910.
Dr. Sydney Ringer, died October 14, 1910.

The deceased Foreign Members are:

Prof. Friedrich Kohlrausch, died January 17, 1910.
Prof. Eduard F. W. Pflüger, died March 17, 1910.
Prof. Alexander Agassiz, died March 28, 1910.
Prof. Stanislao Cannizzaro, died May 10, 1910.
Prof. Robert Koch, died May 27, 1910.
Prof. Giovanni Schiaparelli, died July 4, 1910.
Dr. Melchior Treub, died October 3, 1910.

On the list of Foreign Members of the Society we have thus to mourn the loss of no fewer than seven illustrious names. Of these there is none which we

more deeply regret than that of ALEXANDER AGASSIZ. His frequent visits to Europe brought him into closer personal contact with the Fellows of the Royal Society than is usually possible for our Foreign Members. Only last summer he came once more among us with apparently little diminution of his characteristic capacity for work. But it was his last public appearance, for he died a week or two afterwards on his homeward passage across the Atlantic.

His genius for original research, the unwearied activity with which he pursued those lines of enquiry to which he specially devoted himself, and the generous prodigality with which he placed his ample fortune at the service of science in the investigations which he led and inspired, placed him at the head of the oceanographers of his day. Year after year he traversed, dredged, and sounded the ocean through many different latitudes, bringing back from each cruise enormous collections of material, which went to increase the treasures of that Museum of Comparative Zoology which his father had planned at Harvard, and to which he himself had devoted the strenuous energies of his life. Besides adding much to our knowledge of the fauna of the deep, he ever had an eye for the great physiographic problems which the oceans, their coasts, and their islands present. The pile of goodly volumes in which his incessant labours are chronicled form one of the most remarkable monuments which have been reared in our day by the genius, enterprise, and enthusiasm of a single man.

By the death of STANISLAO CANNIZZARO, at the ripe age of 84, Italy has been deprived of her foremost chemist, and science has to regret the loss of one of her illustrious students, who by his generalisations on chemical combination did so much to place modern chemistry on a sound basis. It happened that at the time of his death the senior Secretary of the Royal Society and myself were in Rome as delegates of the Society to the meeting of the International Association of Academies. We were glad to avail ourselves of the opportunity of attending the funeral of our deceased Foreign Member. It was a touching sight to find that in the class-room where he had so long taught and where his diagrams were still hanging on the walls, the coffin had been placed on his lecture-table and was guarded by a body of his students, who bore it thence on their shoulders, through a dense crowd of mourners to the hearse. Representatives of science from far and near followed the body to the grave.

A veteran astronomer has passed away in GIOVANNI SCHIAPARELLI. From the time of his discovery of the planet Hesperia, made when he was only six and twenty years of age, he prosecuted an active and successful study of the heavens, extending over some forty years at the observatory of Milan.

His notable identification of the orbits of meteors with those of comets, his minute delineation of the surface of the planet Mars, and his subsequent studies of Mercury and Venus, have made his name a household word in astronomical science.

In ROBERT KOCH we have to deplore the loss of one who conferred inestimable benefits on the science of bacteriology. To him we owe the isolation of the tubercle bacillus, the proof that it is the cause of tuberculosis, and the product, tuberculin, for the treatment of this calamitous disease. He has made modern bacteriology possible by his elaboration of methods for the culture of bacilli.

FRIEDRICH WILHELM KOHLRAUSCH, who died in January last, in his seventieth year, will be remembered for his investigation of the methods of measuring magnetic and electrical quantities, for his laborious researches into the conducting power of electrolytic solutions, which formed the foundation of the modern electrolytic theory of solution, and for the great service which he rendered by insisting on the necessity of practical instruction in the laboratory for the teaching of physics.

In MELCHIOR TREUB botany has lost an esteemed and eminent worker. A master of technique, with high intellectual gifts, he attacked many important problems and materially advanced knowledge in the diverse domains of plant physiology, cytology, morphology and geography, presenting his results with great lucidity and grace of style. His scientific work was mainly done while he was engrossed in the official duties of Director of the Buitenzorg Botanic Garden in Java: duties performed for nearly thirty years with such success that the practical benefits which resulted from them to pharmacology, forestry and tropical agriculture are comparable with his scientific contributions. His sympathies were as wide as his interests; and his memory will live in the work which he helped others to achieve as well as in his own.

Coming now to the losses from our Home List during the year that has passed, we have to mourn the death of one of the great historical figures of the Royal Society—SIR WILLIAM HUGGINS. It would be out of place in this brief address to attempt even a summary of the achievements of his distinguished career, but on this anniversary occasion our thoughts naturally turn to the recollection of the salient features of that career which shed such lustre on the Society. Soon after the invention of spectrum analysis as a practical method of investigation was accomplished, only fifty years ago, by Kirchhoff and Bunsen, Huggins resolved to devote himself to the application of this new method to astronomical problems, and, as we all know, he thereby laid the foundations of the wonderful science of astrophysics. His early observations of the spectra of the stars, made before any of the apparatus

now so appropriate for such purposes had been evolved or even thought of, showed his close application and the exquisite refinement of his appliances. In rapid succession he informed us of the similarities in constitution between some types among the fixed stars and our own Sun, and of the marked differences shown by other types, thus leading on to the great fundamental subject of the classification of the stars and initiating the discussion of the order of their evolution. The early application of photography to the spectra of objects whose light is so feeble demanded wonderful patience and skill: it was rewarded with an immediate crowd of physical results in the registration of spectra far beyond the visible limit in the violet, among which the recognition of the second spectrum of hydrogen may be recalled. So, too, at a later time, when the four lines of the ordinary spectrum of this gas were shown by Balmer to belong to a very definite algebraic series, which ought to include numbers of other lines whereof laboratory experiments showed no trace, it was Huggins who called in the aid of the celestial laboratory of the stars and pointed to the exact succession of the missing lines in the spectra of certain stars—thereby infusing new zeal into the efforts of theorists to unravel the secret of the origin of the spectrum.

When the same refined appliances were turned to the scrutiny of the nebulæ, which are spread over such vast regions of the sky, the news soon came that the problem raised by William Herschel and his successors had now been definitely solved by the discovery that these nebulæ were not all clusters of stars, but that some of them shone as masses of glowing gas. In solar work reference may be made to Huggins' proposal to render the flame-prominences visible in open day by great optical dispersion, and also, though the result was less satisfactory, to his persistent attempts to photograph the solar corona by aid of coloured screens. But perhaps the most brilliant of his achievements was his early conception, undeterred by full knowledge of the difficulties which had to be faced, that it might be possible to measure the velocities of approach or recession of the stars by spectroscopic means. In a masterly investigation he proved to the world that his expectation was well grounded, and that the development of instruments specially adapted for this new outlook into astronomy demanded vigorous prosecution. His other laboratory work, all designed for the elucidation of astronomical problems, can only be referred to, such, for instance, as his research into the nature of the luminosity of radium salts.

Sir William Huggins was elected into the Royal Society as far back as 1865. During his long association with us he took the keenest interest in the affairs and the success of the Society. He was repeatedly elected into the Council, where his total length of service amounted to no less than sixteen

years. He served as Vice-President for four years, and we count it as one of the distinctions of the Society in our time that he held the office of our President for five years. Thus, not merely for the lustre reflected from his high reputation in science, but for the personal service which he so willingly and effectively rendered in the conduct of its business, the Royal Society gratefully and affectionately cherishes his memory.

But, great as was his position in scientific discovery, it is within the personal knowledge of most of us that in character he was equally great. His was an ideal life, dedicated throughout to the sublime science for which he did so much, and during many years happy in the devoted companionship and co-operation that eased, and at the same time stimulated, the arduous work of a solitary astronomer.

Dr. Ludwig Mond will be remembered not only for his eminence in chemistry, which was recognised by his election into this Society, but for the indomitable courage and sagacity with which he brought his discoveries into successful practical operation on a commercial scale, and not less for the well-considered and large-hearted liberality wherewith he dispensed the wealth which rewarded his success. The Royal Society has good cause to cherish his memory as that of a genial Member who took an active interest in its affairs, affording it at all times the benefit of his business experience, and ever ready to aid financially any of its enterprises which seemed to him to stand in need of assistance. By his will also he has left a munificent benefaction whereby the Society will ultimately be enriched.

The other deceased Fellows on the Home List are Dr. Shelford Bidwell, Sir Robert Giffen, the Rev. Robert Harley, Mr. John B. N. Hennessey, Dr. Sydney Ringer, Mr. Edward Saunders, Sir Charles Todd, and Mr. C. Greville Williams.

The Report of the Council now presented to the Fellows contains a record of the main features of the work of the Society for the past year. To one or two parts of this work I wish to make brief allusion. It will be seen that, acting on the recommendation of the President and Council of the Society, the Government of this country has agreed to continue its subscription to the International Association of Seismology for six years more, up to the end of March, 1916. This prolongation of the adhesion of Great Britain is eminently desirable, in order that time may be allowed for the consideration of the best means of securing effective international co-operation in seismological observation and enquiry. In this branch of science our country has a special interest, for it was here that modern observational seismology was begun many years ago, and that the first network of observing and registering

seismological stations was established over the face of the globe. To the wide experience, great practical skill, and unwearied enthusiasm of our colleague, Dr. John Milne, the establishment and maintenance of that network of stations have been entirely due. With but little financial assistance from outside, he has borne the whole burden of the organisation, as well as of the voluminous correspondence which it entails with all parts of the world. The valuable service which he has thus rendered to the study of earthquakes has been universally recognised, and there is a widespread conviction that the system of observing stations which he has created is worthy of being made a national undertaking. The whole question of the future of seismology in this country must soon be seriously considered. Meanwhile, I would express my own personal hope that means will be found to place on a more permanent footing the work which Dr. Milne has originated and conducted, and to carry it on as successfully as in the past, but with an enlarged staff and more generous financial aid.

The Fellows are aware that for many years past the Society, at the request of different departments of Government, has undertaken the investigation of various diseases with the view of ascertaining their cause, and, if possible, of suggesting methods of treatment and cure. Chief among these enquiries is that of the appalling disease Sleeping Sickness. From the Report of the Council it will be seen that, although much important information has been obtained in Uganda, the investigation has had to be extended beyond the limits that originally seemed to be requisite, and that probably much still remains to be done before the conditions can be definitely stated in which trypanosome diseases are spread in tropical Africa. The work of those enquirers who are busy in London endeavouring to discover an effective drug for the treatment of trypanosomiasis is still in progress, with results which are so far encouraging for further investigation.

One of the most important statements in the Council's Report is that which has reference to the Gassiot Committee and the future of Kew Observatory. The arrangement therein detailed was the subject of long and careful enquiry and discussion. The Gassiot Committee has now been reconstituted and enlarged so as to make it an effective scientific body of advice in regard to magnetic, seismological or other geophysical observations which are to be conducted under the direction of the Meteorological Office.

Fellows of the Royal Society should be aware that they are divisible into two classes, those who were elected before 1878 and those who were elected after that year. The distinction is a pecuniary one. The older group paid £10 of entrance fee and an annual subscription of £4, which they still continue to pay. They are a dwindling band which now numbers only 57.

The second and younger group, by the institution of what is called the Fee-Reduction Fund, are relieved of the payment of an entrance fee and their annual contribution is reduced to £3, the remaining £1 being paid out of that Fund. When this arrangement was made it seems to have been calculated that the original capital sum of £10,111 5*s.* (which was raised by voluntary contributions), with the invested interest accruing from it, would yield an annual income of £600, which was estimated to be sufficient to meet the highest demand that was likely to be made on the Fund. But these calculations have proved erroneous, partly no doubt on account of the fall in the rate of interest and partly also because younger men have been elected into the Society than was formerly the case, so that the increase in the participators in the benefit of the Fund has not been balanced by deaths to the extent anticipated.

Consequently now, thirty years after the foundation of the Fund, the income, instead of amounting to £600 per annum, has only reached £467 4*s.* 9*d.* while the payments this year should be £474, viz., £150 in respect of fifteen entrance fees and £324 towards the annual contributions of 324 Fellows elected since 1878 and still living. There is, thus, this year, for the first time a deficit, which amounts to £6 15*s.* The excess of the sum which should be paid beyond the income of the Fund will increase annually, though at a diminishing rate, and will probably ultimately amount to about £50. It is obvious, therefore, that some new arrangement will require to be made. The Fellows elected since 1878 might be called upon to increase their annual subscriptions, but such a call would probably be felt to be both inconvenient and undesirable. An alternative would be to increase the capital of the Fund, and this would undoubtedly be the more acceptable solution of the difficulty. If the Treasurer could be put in possession of a sum of at least £1,000 he would be placed in a satisfactory position in regard to this portion of the Society's finances. So long as the deficit remains small the excess of income could be devoted to the increase of the capital, and consequently the sooner the sum required is obtained the better. I commend this matter to the consideration of the Fellows; among whom there are doubtless many who will be as glad to contribute substantial sums as were the original founders of the Fund.

MEDALLISTS, 1910.

Copley Medal.

The award of the Copley Medal has this year been made to one of our own countrymen, who has been more than fifty years a Fellow of the Royal

Society. Sir Francis Galton's life has been one of ceaseless activity in many varied departments of intellectual effort. Few of us can remember how he began as an enthusiastic explorer and geographer, "urged," as he confessed, "by an excessive fondness for a wild life," and with "the love of adventure" as his chief motive. He chose South Western Africa as the theatre of his exploration, penetrated into regions where no European foot had preceded him, and brought back with him a vivid impression of the scenery, physical geography, natural history, and ethnology of Damaraland and South Ovampoland. He embodied his observations in an interesting volume of travel published in 1853. That work showed that he was no mere hunter after game or seeker of adventure, but a shrewd and observant traveller, with his eyes open to every distinctive natural feature in the countries and their inhabitants. His experience in these African journeys led him to plan and to publish in 1854 his well-known and admirable hand-book, the "Art of Travel," which, as a pioneering treatise in the practical methods of scientific exploration, has proved of inestimable service to the travellers of the last half century.

Sir Francis at an early period of his career was led to interest himself in meteorology, which, as a science of observation, was then in its earliest infancy. With much labour and skill he constructed weather-charts, and discussed meteorological statistics. His zeal and success in these studies led to his being chosen a member of the Meteorological Council at its origin, and he remained in that position until the Council was superseded in 1901 by the Meteorological Office. He likewise acted as Chairman of the Royal Society's Committee of Management of Kew Observatory from 1888 till 1900, when the work of this Committee became merged in that of the National Physical Laboratory.

But it was not only in geography and meteorology that Sir Francis Galton manifested his versatile energies. He was much interested likewise in biological studies, especially in regard to questions of relationship and heredity. As far back as 1871 he began what has proved to be a voluminous and important series of contributions to these subjects. From his first paper, "Experiments in Pangenesis," down to his last volume on "Eugenics," his successive papers have shown a continuous development of ideas and conclusions. He was led from his early ethnological enquiries into the mental peculiarities of different races, to discuss the problems of Hereditary Genius, from the fundamental postulate that "a man's natural abilities are derived by inheritance under exactly the same limitations as are the form and physical features of the whole organic world." To obtain further data for the discussion of this subject, he carried out the elaborate statistical

enquiries embodied in his "English Men of Science." Confident in the results of these researches, he proceeded after the manner of "the surveyor of a new country who endeavours to fix in the first instance, as truly as he can, the position of several cardinal points." His results in this quest were given in his "Inquiries into Human Faculty and its Development," published in 1883. A further contribution was made by him in 1889, when his work on "Natural Inheritance" appeared. His subsequent papers and essays on "Eugenics" have still further stimulated enquiry into a subject of such deep interest and transcendent importance in all efforts to improve the physical and mental condition of the human race.

It has seemed to the Council fitting that a man who has devoted his life with unwearied enthusiasm to the study and improvement of many departments of natural knowledge, whose career has been distinguished by the singleness and breadth of its aims, and by the generosity with which he has sought to further them, should receive from the Royal Society its highest award in the Copley Medal.

Rumford Medal.

The Rumford Medal has been awarded to Prof. Heinrich Rubens in recognition of the value of his researches in radiation. For many years he has been engaged in the experimental investigation of optical radiations of very long wave-length. In the course of this work he elaborated, in conjunction with Prof. E. F. Nichols, a method of isolating pencils of nearly homogeneous rays, using the fact that a non-metallic substance reflects very copiously waves of the same length as those to which it is opaque. If then a pencil of rays of mixed wave-lengths is reflected several times to and fro between mirrors of the same kind of substance, the rays finally emerging (the "Reststrahlen") have the wave-lengths of the kinds of light which the substance refuses to transmit. The light of other wave-lengths has been transmitted freely at each incidence, and by a sufficient number of reflections is ultimately removed from the pencil. By using different substances as reflectors, Prof. Rubens has isolated infra-red light of various wave-lengths up to as much as 96μ, or about 0·1 of a millimetre; while, on the other hand, purely electric waves have been produced of wave-lengths as small as 2 millimetres. He has thus enormously extended our knowledge of the infra-red spectrum. Moreover, in conjunction with colleagues, he has investigated the absorbing and reflecting powers of substances for these long wave-length rays. He has shown that, for radiation of wave-length even less than ten times the wave-lengths in the visible spectrum, the reflecting and absorbing powers

of metals and alloys are determined by their electric conductivities alone, in accordance with Maxwell's theory. It followed from Maxwell's own observations on the absorption of gold-leaf for visible light that agencies more complex than conductivity must be involved for these shorter wave-lengths.

Prof. Rubens has recently applied to the measurement of the long infra-red wave-lengths a quartz interferometer, and among other results, he has found that the refractive index of water, for waves of length about 82μ, is of the same order as for waves in the visible spectrum, while for the shortest Hertzian waves yet examined, about 2000μ, it is as high as 9.

These examples will serve to illustrate how much Prof. Rubens has already done to bridge the gap between optical radiations and electric waves produced by direct electric agency, and how much more is to be expected from him in the investigation of the interval still remaining in which such fundamental changes of properties take place.

Royal Medals.

The awards of the two Royal Medals given annually by our Patron the King have received His Majesty's approval.

One of these Medals has been assigned to Prof. Frederick Orpen Bower in recognition of the great merit of his contributions to morphological botany, of which department of science he is the acknowledged leader in Great Britain. Prof. Bower's early studies in this field (1880—82), on the genera *Welwitschia* and *Gnetum*, were marked by the discovery of the true nature of the two persistent leaves in *Welwitschia*. The next period of his work was given to a study of the morphology of the leaf. He developed in 1884 the idea of the phyllopodium or leaf-axis, and discussed in 1885 the apex of the leaf in *Osmunda* and *Todea*. This latter study was cognate to subsequent researches, the results of which were given in 1886 in a review of "Apospory and Allied Phenomena." This work, of much intrinsic interest, is important as having led its author to formulate the views advanced in 1890 in a memoir on "Antithetic as distinguished from Homologous Alternation [of Generation] in Plants." Another memoir, published in 1889, on "The Comparative Examination of the Meristems of Ferns as a Phylogenetic Study," prepared in the light of the then received belief that the leptosporangiate ferns are the more primitive, was followed in 1891 by a discussion of this question in which Prof. Bower advanced morphological reasons for reversing the hitherto accepted phylogenetic order. The new conclusion has proved to be in accord with palæobotanical results, and marked another distinct step in the advancement of botanical science.

During the third period of his work, 1892—1903, Prof. Bower's papers, including an important series on the spore-producing members, have resourcefully maintained the antithetic doctrine, and have afforded a striking instance of the advantage of a well-considered working hypothesis as a guide to investigation. The career of morphological research here outlined has been recently crowned by the publication (1908) of a book on "The Origin of a Land Flora," which is one of the "most important contributions to the advancement of Natural Knowledge, published originally in His Majesty's dominions," within the period prescribed in respect of the award of Royal Medals.

The other Royal Medal has been adjudged to Prof. John Joly, who is eminent in two branches of science, geology and physics. This combination of studies has proved to be reciprocally fruitful to both departments. It was from his mineralogical interests that he was led to devise the steam calorimeter, which has enriched physics with an apparatus of high refinement. The use of this method was extended by him to the direct determination of the specific heats of gases at constant volume, a measurement dealing with minute quantities of heat under circumstances quite beyond the capabilities of the usual forms of calorimeter. Among many contributions to standard physical data, which are accepted and in use, may be instanced his determination of the density of saturation of steam. His meldometer, primarily intended for determining the melting points of mineralogical and geological specimens, has been the means of providing data for use in thermometry. He has devised and applied a method of determining the change of volume of rocks and other substances on fusion, which is a datum of primary importance for cosmical theories. He has carried out a refined research, with negative results, on the possibility of minute change of mass (as distinguished from weight) accompanying chemical combination. His recent extended investigations of the occurrence of radioactive substances in materials from various strata have been utilised for fundamental geological discussions. Of other useful inventions which he has introduced, one of the best known is the translucent block photometer.

Prof. Joly has made important contributions to the subject of colour photography, and devised some years ago a three-colour system in which all three colours are present on the same plate in the form of fine parallel lines or small dots.

He has also contributed substantially to the theory of biological processes, such as the ascent of sap in vegetation. Reference may likewise be made to his suggestive memoir on the Age of the Earth based upon a discussion of the chemical constitution of the Ocean.

Davy Medal.

The Davy Medal has been assigned this year to Prof. Theodore W. Richards, as a mark of appreciation of the value of his work in the determination of the atomic weights of the elements. His researches on this subject have not been surpassed in comprehensiveness by those of any other chemist. He has himself determined the atomic weights of no less than 14 elements, and many other atomic weight determinations have been made under his direction and superintendence. The accuracy of the numbers obtained is certainly much higher than that which has been attained by any previous series of researches, and it is impossible to speak in too high terms of the ingenuity, the unremitting labour, and the masterly manipulation which Prof. Richards has brought to bear on his investigations.

In addition to this work on atomic weights, Prof. Richards has made many important contributions to physical chemistry, and it is probably no exaggeration to say that he has done more to raise the standard of accuracy in physico-chemical work than any other living chemist. Theoretical contributions to this branch of science are comprised in a series of papers on "The Possible Significance of Changing Atomic Volume," in which he suggests a relation between the energy of the atoms and their compressibilities. In order to test his hypothesis, he has made a long series of investigations on the compressibility of elements and compounds. He has determined this constant for nearly all the solid and liquid elements, and he has shown that the compressibility is a periodic function of the atomic weights. In electro-chemistry, Prof. Richards has made important determinations of the electro-chemical equivalent of silver, and he has supplied some of the most rigorous proofs of the universality of Faraday's Law.

Darwin Medal.

To Mr. Roland Trimen, who was for many years Curator of the South African Museum, in Cape Town, the Darwin Medal has been awarded. His official position, and the duties it involved, enabled him to do admirable work in African zoology. His name will always stand with those of Bates and Wallace in the establishment and illustration of the theory of mimicry. In addition to his researches on that subject, he has done admirable systematic work, his descriptions of insects, especially the *Lepidoptera rhopalocera*, being models of accuracy and literary style. He, furthermore, rendered the greatest assistance to Charles Darwin, especially in his work on orchids—assistance the high value of which is acknowledged in a long series of that great naturalist's published letters.

Sylvester Medal.

The Medal which perpetuates the name and mathematical prowess of James Joseph Sylvester has this year been assigned to Dr. Henry Frederick Baker, in recognition of his work in the Theory of Functions, wherein he has shown himself to be a profound analyst. His book on the Abelian Functions, published in 1897, is a classic, and probably no better guide to the analytical development of pure mathematics has appeared during the last three-quarters of a century. While basing the argument of the work on the methods of Riemann, he never loses sight of the arithmetical ideas which we owe to Kronecker, Dedekind, and Weber, or of the geometrical notions brought to light by the labours of Clebsch, Gordan, Noether, and Klein. The critical insight which was thus in evidence marked him out a few years ago as the editor of Sylvester's Collected Papers. This work, which, with the approaching issue of the fourth and last volume, may be said to be complete, has been necessarily a difficult task, which besides making demands upon the resources of an accomplished mathematician has entailed no little editorial labour. Dr. Baker, by explanatory and critical observations, and by frequent ameliorations of the text, has done much to assist mathematical students. His scholarly work has resulted in a faithful record of the course of Sylvester's thought. It seems eminently fitting that the Sylvester Medal should be given to one who has erected so lasting a memorial to the great mathematician.

Hughes Medal.

To Prof. John Ambrose Fleming the Hughes Medal has been awarded. For thirty years he has been actively engaged in researches in experimental physics, chiefly in the technical applications of electricity. He was an early investigator of the properties of the glow lamp, and elucidated the unilateral conductivity presented in its partial vacuum between glowing carbon and adjacent metal, a phenomenon which has been linked up recently with the important subject of the specific discharges of electrons by different materials. He has published in the scientific and technical press, and in technical text-books, many admirable experimental investigations and valuable expositions in the applications of electricity, as, for example, to electric transformers and wireless telegraphy. Of special interest and value for theory were the important results concerning the alterations in the physical properties of matter, such as the remarkable increase in the electric conductivity of

metals, when subjected to very low temperatures, which flowed from his early collaboration with Sir James Dewar in investigating this domain. In recent years he has taken a prominent part in the scientific development of telegraphy by free electric waves.

The Action of Bacillus lactis aërogenes *on Glucose and Mannitol.* Part II.—*The Investigation of the* 2 : 3 *Butanediol and the Acetylmethylcarbinol Formed; the Effect of Free Oxygen on their Production; the Action of* B. lactis aërogenes *on Fructose.*

By G. S. Walpole, B.Sc. (Melbourne).

(Communicated by Dr. A. Harden, F.R.S. Received October 22, 1910,—Read January 19, 1911.)

(From the Bio-Chemical Laboratory, Lister Institute.)

A preliminary communication on some of this work has been published.* The present paper deals with the experimental part of the investigation in question, and some new results are recorded. On examining the action of *B. lactis aërogenes* on glucose, it was found that the carbon content of the products isolated was not so great as that of the original glucose employed. A further examination disclosed that a quantity of a neutral liquid was present containing the amount of carbon needed to explain this discrepancy. As, in the preliminary communication, justification was shown for calling this liquid "crude butylene glycol," the use of this convenient name will be continued here. The object of this investigation was to determine as far as possible the nature of the constituents of this material, and the proportions in which they are found therein.

The Conditions of Cultivation of the Organism.

In all the earlier experiments the organism (*B. lactis aërogenes*) was grown anaërobically in a medium containing 1 per cent. of Witte peptone, 2 per cent. of pure glucose, and an excess of chalk. Later, other sugars were used, and sometimes, when using glucose, the percentage of sugar employed was raised to 5, in order to obtain larger yields of one particular product per

* Harden and Walpole, 'Roy. Soc. Proc.,' B, 1906, vol. 77, pp. 399—405.