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Discovery and Invention

THE importance of scientific research in the modern State no less than in industry encourages discussions from time to time as to the mechanism of discovery and the best means of encouraging it. Dr. Lampitt, for example, in a recent address on fundamental problems of the food industry, stressed the importance even in industrial research of a true spirit of inquiry, the lack of which was liable to lead to unsound work which later investigators would invalidate. In stressing the importance of the spirit in which problems are faced he had in mind chiefly, however, the importance of a critical attitude towards experimental methods and published results ; he uttered a much needed warning against the tendency to assume the validity of such results and the adequacy of an experimental technique without any rigorous verification of its suitability for the particular purpose in mind.

It is unfortunately true that the critical spirit is not so general a characteristic of the young research worker, whether in industry or in academic work, as is desirable, but this is only one indication that scientific training sometimes fails to impart the scientific spirit or the secret of scientific method. A discussion recently held by the Institution of Mechanical Engineers starting from a group of papers on invention and the inventor, made a valuable contribution in this field by its attempt to elucidate the mental characteristics of the successful inventor—an attempt in which we have made singularly little progress since the days of Francis Bacon.

Some of the chief inventions upon which modern industrial development is founded, such as the steam engine, the power loom, printing and gunpowder, were all made by persons working independently of scientific research. It is true that the discoveries of science enlarged the bounds of invention and opened up much more fruitful fields for the inventor, but the technique, like the motive of discovery, differs essentially from that of invention. This is so widely true that the adequacy of invention as a basis of industrial progress is questioned by some shrewd observers, who look instead to the much wider use of scientific methods in the acquisition and application of new knowledge.

It is interesting, in this connexion, to note that Dr. Lampitt attributed the unsatisfactory position of our knowledge of food problems partly to the

use of hit or miss methods. Such methods have occasionally been successful, as witness Charles Goodyear's discovery, after ten years of such haphazard work, that sulphur was the agent necessary to effect vulcanisation. They are too prodigal of time and money to be applicable under the team work conditions prevalent in modern industry, and the firm or industry which clings to them is destined speedily to be outstripped by its competitors.

Without providing us with a full philosophy of discovery, the discussion to which we refer, although relating mainly to invention, is highly suggestive in material from which such a philosophy might be evolved, or at least in stressing factors to be cultivated in the training of those undertaking a career of scientific research. The importance of accurate observation and experimental ability need no further discussion. They have been accepted since Galileo's day as the basis of scientific research, and Bacon's exposition of the possibilities of the scientific method assumed their use in the formulation and verification of hypothesis.

The importance of an accurate knowledge of the present position as a starting-point if duplication of effort is to be avoided should be obvious, but the importance of sifting that knowledge is often missed, as is the danger of paralysing initiative through excessive knowledge of detail. At this point our modern examination system exercises some of its most baneful effects. Only a clear understanding of what is involved in the scientific method, and a firm grasp of its essential principles, can enable the young investigator to-day to find his way through the literature bearing on his problem and avoid alike the mortification of merely repeating some previous work and the deterring or deadening influence of massed knowledge. Creative science is as dependent as creative art upon a sense of values, and upon intuition linked to imagination.

The further suggestion was made that youth is an important factor in creative work. By this we must understand the resilience and alertness of mind which are characteristic of those between twenty-five and forty years of age, but by no means their monopoly. Beyond that age, maturity of judgment and experience tend to be offset by habits of conservatism and complacency, not to mention the bondage of the preconceived idea from which comparatively few are able to free themselves. So far as science is concerned, however, rash is he who attempts to fix an age limit beyond which brilliant discovery and creative thought are rare and unexpected. On the contrary, Bavink pointed out quite recently that the really important discoveries in modern science are mainly the work of those who have long been at a position of eminence in their chosen field.

If the charge of 'grooviness' or lack of receptivity can rarely be brought against the real leaders of scientific thought, the important contributions which have come from those outside the industry in which the discovery or invention finds scope is a significant reminder of the value and inspiration which a fresh outlook may possess. This is true not merely of scientific discovery but of invention also. Benjamin Huntsman was a clockmaker whose desire for better steel for his springs constrained him to invent crucible steel. Henry Gort was a navy agent when he invented the puddling process for wrought iron; and Arkwright was a barber before he applied himself to the problems of spinning.

To the influence of professional organisations which may at times impede progress we have recently referred, but there are other personal qualities which are important. The ability to utilise the literature without being suppressed by it is largely dependent on a capacity for assimilation which in genius is often limited to a narrow field. The born organic chemist may be almost unteachable as regards mathematics, and a mechanical genius may find electricity a sealed book.

The place of initiative in the make-up of the investigator has already been emphasised. The capacity for concentrated effort is another important factor, and while a capacity for taking infinite pains does not constitute genius, genius is rarely without that capacity, at least in directions which serve its ends. Moreover, this capacity for concentrated effort is closely related to that desire to see the work executed in the most thorough and efficient way which is an essential part of the scientific spirit.

There are many other qualities which are to be found or desired in the scientific investigator and which condition his success whether in industrial or in purely scientific work. In both, the capacity for co-operation is of growing importance. Both classes are required, though in varying degree, to co-operate with other workers, sometimes in different branches of science, in an attack on a 'common objective'. Both are sometimes concerned with

enlisting the interest and support of those possessing merely traditional or practical knowledge ; and both are also interested in the wider dissemination of the new knowledge, particularly in our technical schools.

To get a more scientific basis into industry, particularly our traditional industry, involves close co-operation between the man of life-long experience and the scientific worker. Such co-operation has a cumulative effect. It does far more than merely assist in the conduct of the industry on scientific lines, the solution of fundamental problems, or the reconciliation of art and industrial practice and craftsmanship. The new problems it throws up provide a continual and invaluable stimulus to the scientific worker, which of itself is likely to yield rich fruit in the creative work which it incites.

Röntgen, and the Discovery of X-Rays

Wilhelm Conrad Röntgen : and the Early History of the Roentgen Rays. By Otto Glasser. With a Chapter : *Personal Reminiscences of W. C. Röntgen*, by Margaret Boveri. Pp. xii+494. (London : John Bale, Sons, and Danielsson, Ltd., 1933.) 32*s*. 6*d*. net.

LOOKING backward we can see very clearly the monumental character of the discovery of the X-rays by Wilhelm Conrad Röntgen in November 1895. This was truly the beginning of the 'new physics' and the first of a series of profound and basic revelations, which even now show no sign of ending. It is given to few men of science to make discoveries which attract world-wide and lasting attention, but the X-rays with their amazing penetrating powers, and their immediate and beneficent application in medicine, made an appeal to men of science and laymen alike, which is not likely to be surpassed in our time. Röntgen's discovery in fact, as Sir J. J. Thomson remarked in his Rede lecture on July 10, 1896, "appealed to the strongest of all human attributes, namely, curiosity".

The recent publication of a biography of Röntgen by Dr. Otto Glasser is a timely reminder of very stirring days. At the period of his discovery, Prof. Röntgen was in his fiftieth year, and held the position of director of the Physical Institute of the University of Würzburg. He was born at Lennep in the German Rhineland, but his early youth was largely spent in Holland, to which country his parents emigrated when he, an only child, was three years old. He had a chequered school life at Utrecht, which ended in his taking up at the age of twenty years the study of mechanical engineering at the Zurich Polytechnic School. Three years later he obtained his Ph.D. and was appointed assistant to Kundt, who had succeeded Clausius in the chair of physics at Zurich. Kundt's friendship helped to settle Röntgen's future career for him, and he accompanied Kundt when the latter was called to Würzburg and afterwards to Strassburg. At the age of thirty-four years, Röntgen was appointed professor of physics at Giessen, and nine years later (in 1888) succeeded Kohlrausch at Würzburg.

Röntgen's interests were spread over a wide range of physics, though most of his published papers dealt with heat and general physics. He devoted, however, considerable attention to pyro- and piezo-electrical effects in crystals, and in 1888 he conducted important fundamental investigations which established the magnetic effects resulting from the motion of a dielectric between two electrically charged condenser plates. Röntgen's outlook on physics was thoroughly classical and his natural bent for exact experimental work, which had been strengthened by the influence of Clausius, remained with him all his days. He made little use of mathematics, but got his results with ingenious and simple equipment much of which he constructed himself. He greatly appreciated an ability to improvise apparatus, and held the view that a man should be able to make everything really necessary with a pocket knife. It is, therefore, not surprising that he normally dispensed with the services of an assistant and preferred to make his own observations.

Röntgen had been at Würzburg some five years when, in the early part of 1893, Helmholtz (then president of the Reichsanstalt) in a remarkable paper published in *Wiedemanns Annalen* in 1893, predicted the properties of electromagnetic waves of various lengths, and *inter alia* forecast a high penetrating ability and small refrangibility for waves of atomic dimensions. There is no evidence, however, that Röntgen was influenced by this paper when in October 1895 he decided to make some experiments with cathode rays. Rather would it appear that he was attracted by the contemporary work of Hertz and Lenard on electrical discharges in evacuated tubes. Following Lenard's practice, Röntgen completely enclosed the discharge tube within black paper. The room was darkened and Röntgen, who was working alone

late in the evening, saw a small piece of paper painted with barium platino-cyanide and lying on the bench, shine out brightly. This was on Friday, November 8, 1895. Röntgen kept his own counsel for several weeks, apparently telling neither his staff nor his wife, who could find no explanation of his lateness for meals, his lack of appetite, his ill humour, his complete absence of conversation and his hurried returns to the laboratory. Röntgen was, in fact, slowly convincing himself by repeated experiments that he was not the victim of hallucination and that here was a new type of radiation with penetrating powers which appeared incredible. He presently came to appreciate the full significance of his discovery, and with the remark to his wife "Now the devil will be to pay" released his momentous announcement in the form of a preliminary communication "On a New Kind of Rays" which he presented to the Physical Medical Society of Würzburg at the end of December during the Christmas recess.

This paper was printed and circulated prior to reading. In it Röntgen clearly identified the source of the "X-rays", as he styled them, with the region of impact of the cathode rays on the glass walls of the tube. He also established the dependence of the penetrability of the rays on the density and thickness of the obstacle, their properties of exciting fluorescence and affecting a photographic plate, the absence of regular reflection or of appreciable refraction (the refractive index of water was less than 1·05), the absence of magnetic deflection, etc. He inclined to the view that the rays were longitudinal vibrations in the ether. The paper was supplemented by shadow pictures of many objects, including the bones of the hand.

Röntgen sent copies of his paper and X-ray pictures to a number of friends, including Sir Arthur Schuster at Manchester, who wrote an article on the rays in the *British Medical Journal* of January 11, 1896. The news of the discovery first reached London on January 6 and was thence cabled the world over. Röntgen's paper was speedily translated into many languages. NATURE first referred to it on January 16, and followed this up with a translation of the complete paper on January 23. Mr. Campbell Swinton appears to have published in January the first X-ray photograph taken in Great Britain. On January 27, Sir J. J. Thomson described his experiments on the X-rays to the Cambridge Philosophical Society, experiments which, one recalls, speedily led him to the study of gaseous ionisation and conduction, followed a year later by his discovery of the electron. The world acclaimed another monumental discovery, and the Cavendish Laboratory, under its famous chief, became a magnet for the physicists of every land.

Among other British X-ray pioneers were Sir Oliver Lodge, Lord Blythswood, Prof. A. W. Porter, Dr. J. MacIntyre, Prof. Silvanus Thompson, Sir James Mackenzie Davidson and Sir Herbert Jackson, each of whom made important contributions. The first journal in the world to be devoted exclusively to X-ray matters was founded in Great Britain by Sidney Rowland in May 1896, under the title of *Archives of Clinical Skiagraphy*. This is now the *British Journal of Radiology*. The British Röntgen Society, which was founded in 1897, was also the first society to be originated in any country with the object of studying the X-rays. Röntgen was one of its first honorary members.

Dr. Glasser's arresting book includes many examples of the amazing interest excited in the public press, both popular and scientific. Ludicrous misconceptions prevailed in many quarters. The new rays would render privacy impossible. The *Pall Mall Gazette* in March 1896 referred to the "revolting indecency" of it all and called for legislative restriction of the severest kind. Mr. *Punch* found repeated inspiration in the rays for both rhyme and cartoon. The most fantastic stories found credence, despite openly voiced scepticism in some quarters of any semblance of truth in the discovery. Reams of sensational matter emanated from Edison's laboratory in America: "he and his staff worked through seventy hours without intermission, a hand organ being employed during the latter hours to assist in keeping the force awake". Fortunately the pace was too hot to last, but until the general fever of excitement had abated, the new rays became in many countries the tool of the charlatan, who exploited them as his fancy lay, whether in the direction of alchemy, vivisection, spiritualism, telepathy, soul photography or soothsaying.

On March 9, 1896, Röntgen submitted his second communication to the Würzburg Physical Medical Society. He refers to the superiority of a platinum target as a generator of X-rays and the successful use of a concave cathode and a 45° target (a design which Crookes had developed in 1879 for other purposes). He remarks on the usefulness of a Tesla transformer as a means of exciting an X-ray

tube. Most of the memoir is devoted to the action of X-rays in discharging electrified bodies in air.

A year later (March 10, 1897) Röntgen published his third and last memoir. He remarks on the scattering of X-rays by air, on the general uniformity of emission of X-rays from a tube in different directions, on the different penetrating powers of rays from 'soft' and 'hard' tubes, on the gradual hardening of X-ray tubes with use, etc.

After his third memoir Röntgen published little more on X-rays. He left Würzburg in 1900 for Munich, where he resumed his early researches on the physical properties of crystals. Laue's famous crystal diffraction experiments on X-rays in 1912, followed by those of the Braggs, must have afforded Röntgen great gratification. He himself had unsuccessfully tried to reflect and diffract the rays, and he also lived to see in 1922 A. H. Compton specularly reflect X-rays from glass and silver at tiny glancing angles. In 1924, a year after Röntgen's death, Siegbahn and his coadjutors prismatically refracted the rays, the angle of deviation for a glass prism amounting to only a few seconds of arc, the refractive index being less than unity, as forecast by the classical Drude-Lorentz theory of dispersion. In 1925, A. H. Compton and Doan successfully diffracted the X-rays by the use of ruled gratings on speculum and extremely small glancing angles. The nature of the X-rays was long the subject of controversy, but these several experiments all played their part in finally establishing the position of the rays as radiation with wave-lengths of the order of atomic magnitude.

For some years distinctions were lavished upon Röntgen, but his essential modesty and shyness remained unaffected. He refused to derive any financial advantage from his discovery, nor would he consent to lecture either to the Reichstag or the British Association. He received jointly with Lenard the Rumford medal of the Royal Society. He declined the title 'von', and the offer of the presidency of the Reichsanstalt in 1904. The first Nobel prize for physics was awarded to him in 1901, and in his will he left the prize to the University of Würzburg, but this together with his personal fortune became valueless as a result of the deflation after the War.

Miss Boveri, a close friend of Röntgen, contributes to Dr. Glasser's book an intimate personal study of Röntgen. There is an amusing story of how Röntgen, who had an excitable temperament and had been rather spoiled as a boy, became embroiled in a terrific argument with his wife during a walk. In his anger he stopped a passing cab, bundled her into it, paid her fare home and continued his walk alone. He was fond of cards, but a bad loser: he would pound the table when his hand was a poor one, and if his partner played badly he would become so angry that some of his friends refused to play with him under any consideration. However, these were minor weaknesses. He was kind-hearted and fond of children, and having none of his own, adopted a niece of his wife's. Röntgen, who was cautious, reserved and extremely independent, did not make friends easily. He was fond of outdoor life, and never lost his love of certain of the Swiss alpine resorts, where his tall athletic bearded figure was well known. He had a strong aversion to motor-cars. Everything he did he took up with great intensity and zest. He hated speeches and rhetoric in any form and his lectures, sound and clear though they were, did not make wide appeal to his students. He refused, as he said, to 'pamper' them, and the ill-prepared dreaded his examinations, because he did not regard routine questions as a test of intelligent knowledge.

During the War Röntgen allowed himself to be persuaded into signing the proclamation of the 'ninety-three intellectuals' and gave up his Rumford medal to be melted for gold, but in his later and calmer years he regretted that he had been led into such matters. He derived great consolation that his discovery had contributed so much to the amelioration of the suffering of the wounded among friend and foe. He died in his seventy-eighth year on February 10, 1923.

Many have wondered that the discovery of X-rays had not been made long before it fell to Röntgen, for numerous workers must have produced the rays in abundance, certainly during the previous fifteen years. It was perhaps inevitable, therefore, that the flood of contemporary appreciation was tinged here and there with not over-kindly comment, but in looking backward we may recall with Dr. Glasser the words of Kircher, a seventeenth century predecessor of Röntgen, who remarked, "Nature often allows amazing miracles to be produced which originate from the most ordinary observations and which are, however, recognised only by those who are equipped with sagacity and research acumen, and who consult experience, the teacher of everything".

G. W. C. Kaye.

Physical Chemistry of the Proteins

Handbuch der Kolloidwissenschaft in Einzeldarstellungen. Herausgegeben von Prof. Dr. Wolfgang Ostwald. Band 6: *Kolloidchemie der Eiweisskörper.* Von Prof. Dr. Wo. Pauli und Dr. Emmerich Valkó. Zweite völlig neu bearbeitete Auflage. Pp. xiv+353. (Dresden und Leipzig: Theodor Steinkopff, 1933.) 28 gold marks.

THE first edition of this monograph was published in 1920; since that time there have been important developments both in the theoretical and the practical aspects of this subject, among which may be mentioned the conception of the amino acid as a *zwitterion*, the general adoption of the activity notation, the measurements of molecular weights of proteins and the application of the interionic attraction theory of strong electrolytes to protein systems.

In the preparation of the second edition, Prof. Pauli has been assisted by Dr. Valkó, who is joint author with him of the larger textbook "Electrochemie der Kolloide". The authors are to be congratulated in that they have gone far towards the achievement of the purpose set forth in the general preface to the series of monographs by their general editor, Prof. Wo. Ostwald, namely, that the publications should serve the purpose of collecting and correlating papers on the subject of colloid science that are widely dispersed through an extremely large number of diverse journals. The authors have amassed data from physical, chemical, biological and technical publications, and the mode of presentation is much to be commended, in that the results under discussion are largely given in the form of tables and curves, and diagrams descriptive of the technique employed are provided in many cases.

The chapter in which the mobilities of protein ions are discussed is of special value, as it includes a description of the methods and results of Tiselius, which were published in a journal difficult of access. The section dealing with the hydration of proteins is a lucid and discriminating summary of the subject, in which special prominence is given to the interesting researches of Sørensen, of Weber and of Moran.

The reference made to the work of Sørensen, Linderstrøm-Lang and Lund is rather brief in view of its importance. Their paper included the first definition of the isoionic point, and a comprehensive study of the effects of salts on the ionisation of proteins. The studies of gas and electrolyte equilibria in the blood, published by Van Slyke and his colleagues, have been omitted.

It is to be regretted that the second chapter, entitled "The Chemistry of Proteins", should be so short, and that allusion to the stimulating papers of Max Bergmann should be restricted merely to references. The hypothesis due to K. H. Meyer and Mark, that the protein molecule consists of a long main valence chain, is given greater prominence. Reference is made to Meyer's hypothesis that protein exists in solution in the form of aggregates or micelles. In the light of Svedberg's work on the constancy of the molecular weights of proteins over a range of protein concentrations described in Chap. xiii, it would seem that the aggregation theory cannot have an universal application. Svedberg has shown, moreover, that in the case of many proteins, the sedimentation velocities agree with those calculated for spherical molecules.

The recent investigations of Sørensen and his colleagues on the fractionation of proteins, and the solubilities as affected by the mass of the solid phase, are described in Chap. vii. Sørensen has concluded that purified proteins are not chemical individuals, but systems of components which dissociate reversibly. The solubilities of fractionated globulins indicate that the solid phases may be complexes of eu- and pseudo-globulin.

Many tables of data relating to the physical properties of proteins, including their dielectric constants, have been given; a very considerable part of this material is not available in any other textbook on proteins. As an inclusive summary of recent investigations in this field, the handbook of Pauli and Valkó should be most useful to those interested in the physical chemistry of the proteins.

G. S. Adair.

Micro-organisms and Insects

L'Infection chez les insectes : immunité et symbiose. Par Dr. A. Paillot. Pp. 535. (Lyon: Librairie médicale et scientifique, 1933.) 100 francs.

DR. A. PAILLOT has devoted a number of years to the study of the diseases and other microbic infections of insects. In the present work he reviews various aspects of insect microbiology and incorporates the result of his own researches. The broader theoretical problems of immunity and symbiosis are discussed at length, while the morphology and biology of a large

number of disease, and other, organisms are clearly described and figured. This volume is not an exhaustive treatise on its subject; such an aim was not the author's intention. The reader will find some phases more fully treated than others, while certain aspects are omitted, or come in for very cursory mention.

The book is divided into seven parts: of these, the first four parts deal respectively with maladies of protozoan origin, fungal diseases, diseases due to viruses and to bacteria. The fifth part is concerned with anti-bacterial immunity and its phases among insects. The author discusses at length the subject of natural and acquired immunity and concludes that they are due to both cellular and humoral reactions. He considers, however, that the experimental evidence shows that the reactions of the blood plasma itself are of greater importance in this aspect than cellular, or phagocytic, activities.

Part six is a very full account of symbiosis in various species of aphides. Symbiosis is not discussed with reference to other insects since the author's original observations are concerned with the group just mentioned. This part includes a very full account of the cytology and the transmission of the specific micro-organisms from generation to generation of their hosts. The biochemical side of the subject is not discussed and we are still in the dark as to the nature of the mutual reactions that are involved. Dr. Paillot elaborates the interesting theory that symbiosis in aphides has developed from bacterial infection. The micro-organisms, he claims, have been able to establish their permanent relationship owing to a progressive diminution of their virulence, so that they have become completely inoffensive and ultimately beneficial. Part seven is concerned with the practical side of insect microbiology. The utilisation of disease organisms in pest control and their rôle in the transmission of human and animal maladies are discussed in this section.

The book concludes with a classified bibliography, running to about fifty pages, together with indexes to subjects and authors' names.

A. D. IMMS.

Short Reviews

Allen's Commercial Organic Analysis. Vol. 10: *Hæmoglobin and its Derivatives, Albuminoids or Scleroproteins, Structural Proteins, Examination of Foodstuffs for Vitamins, the Hormones, the Identification of Unknown Woods and Charcoals, the Pectic Substances.* Editor: Dr. C. Ainsworth Mitchell. Fifth edition, revised and partly rewritten. Pp. xi+817. (London: J. and A. Churchill, 1933.) 32*s.*

WITH the publication of the tenth volume of "Allen's Commercial Organic Analysis", the fifth edition of this comprehensive work is completed. A decade has passed since the issue of the first volume of this edition and, in the interval, many branches of applied chemistry have increased in importance; even now a part of this edition is out of date, especially for data contained in the volumes published so far back as 1924 or 1925. The editor has taken advantage of the issue of this final volume to include a number of subjects of recent technical importance, so that there is no definite connecting link between the subject matter of the various chapters. These new sections include such subjects as hæmoglobin, albuminoids, vitamins in foodstuffs, hormones and special wood charcoals. A section on fibroids in a former edition has now been extended and includes a large amount of data on natural and artificial silk, furs, hairs and wool. Pectin substances have been given special consideration and the qualitative and quantitative examination of such substances is considered.

The reviewer has had an opportunity of checking the methods of pectin analyses given in the work and finds them very detailed and reliable. In the estimation of pectin substances (p. 524) there is an inaccuracy in the making up of the standard solution, and the subsequent statement that a molecule of furfural liberates exactly two atoms of bromine from potassium bromide might be expressed differently.

This final volume also includes a useful 250-page subject index supplement for the whole edition. The fifth edition of 'Allen' is the most authoritative and complete work on commercial or applied organic analysis which has ever been published. It is absolutely indispensable to the analyst and works chemist, and no chemical reference library will be complete without it. J. REILLY.

A Handbook of Child Psychology. Edited by Carl Murchison. (The International University Series in Psychology.) Second edition revised. Pp. xii+956. (Worcester, Mass.: Clark University Press; London: Oxford University Press, 1933.) 24*s.* 6*d.* net.

IF one turns over the pages of a psychological treatise written a generation or two ago, one finds that what it mostly comes to is a patient analysis of adult consciousness, the method employed being that of introspection. Experimental psychology, involving objective measurement and claiming to be scientific, was slowly making its way, and is now very extensively cultivated. Of child psychology the same can

scarcely be said. James Sully's "Studies of Childhood" (1895) was in Great Britain a pioneer book and is still quotable. But certainly not in Great Britain, nor even in the United States, has child psychology received the attention of the ablest investigators to the extent which one would have thought to be its due. Therefore genetic as distinguished from analytic psychology has suffered.

That progress is being made, however, is shown by the latest addition to the International University Series in Psychology. So rapidly is the subject advancing that this second edition of the "Handbook of Child Psychology" bears little resemblance to the first, published little more than three years ago. In twenty-four closely packed chapters the latest work on the scientific study of children is summarised, not for the general reader, but for experts, by experts. As the book is of American origin it would in any case have been natural that most of the contributors should be American, but as a matter of fact it was inevitably so, because most of the research work has been done by Americans. Single contributions come also from Toronto, Vienna, Berlin and Geneva, but none from Great Britain. Ten of the contributors are women, one of whom makes a remark which some of the men would do well to take to heart: "Too much work upon these problems is being done with paper and adding machines, and too little with human beings".

Recent Advances in Psychiatry. By Dr. Henry Devine. Second edition. Pp. xi+364. (London: J. and A. Churchill, 1933.) 12*s.* 6*d.*

It is very gratifying to note a marked improvement in the second edition of this book. The first edition was very good, but Dr. Devine is to be congratulated on the additions and alterations he has made. Three new chapters have been added, dealing with "Germinal Inheritance in the Psychoses", "Mental Disturbances in Pernicious Anæmia" and "Mental Disorders and Deficient Oxidation".

It is a very great pity that the work on toxic foci in the psychoses is practically uncontrolled. There is need of the investigation of a series of 1,000 normal cases, particularly with reference to the presence of infections in the sinuses and the bowel. The work of the toxic schools is unconvincing without control.

We would like to have seen some mention of the use of diathermy in the treatment of general paralysis of induced pyrexia. The use of malaria is attended by a certain death-rate due to the malaria alone. The results from diathermy are just as good as from malaria, particularly if combined with tryparsamide. In the next edition, will Dr. Devine give us a chapter devoted to occupational therapy, which plays such a very important part in the modern treatment of mental illness?

This is one of the best British books on psychiatry.

Handbuch der Physik. Herausgegeben von H. Geiger und Karl Scheel. Zweite Auflage. Band 24, Teil 1: *Quantentheorie.* Redigiert von A. Smekal. Pp. ix+853. (Berlin: Julius Springer, 1933.) 79 gold marks.

The advances in quantum theory have of late been so rapid that most workers in theoretical physics must appreciate the publication of vol. 24 of the well-known "Geiger-Scheel Handbuch der Physik". Part 1 of this volume is now available; unfortunately, it is impossible to do more than outline its contents here. It contains a description of the origin and development of the older or classical quantum theory by Rubinowicz, followed by a treatment of the general principles of wave mechanics by W. Pauli. Bethe discusses the quantum mechanics of one- and two-electron problems, while Hund contributes a very important article on the quantum mechanics of atomic and molecular structure. Wentzel is responsible for a section on collision and radiation processes, and N. F. Mott contributes the concluding section on the application of wave mechanics to nuclear physics. The whole production is of the same high standard of excellence as its precursors.

Manipulative Surgery. By A. S. Blundell Bankart. (Modern Surgical Monographs.) Pp. xii+150+17 plates. (London: Constable and Co., Ltd., 1932.) 7*s.* 6*d.* net.

If the practice of manipulative surgery is almost a monopoly of the bone-setter, the medical profession alone is to blame. The art of manipulation, with its therapeutic indications and contra-indications, has received but scanty attention in the curriculum of the medical student; the average doctor's complete ignorance of the subject is not surprising. Mr. Bankart's book, which is intended for the student and general practitioner, is consequently of value in two ways. It demonstrates that a large field of minor orthopædic practice is well within the limitations of any doctor who cares to learn its principles and who remembers his studies in anatomy; and to the physician who does not wish to acquire the art it indicates the large number of conditions which can suitably be referred to the orthopædic surgeon, instead of being allowed to drift into the risks of treatment by the unqualified practitioner.

The Blue Book, 1934: the Directory and Handbook of the Electrical and Allied Industries. 52nd edition. Pp. 1474+xxx. (London: Benn Bros., Ltd., 1934.) 25*s.* net.

This handbook is almost a necessity to everyone engaged in the electrical industry. The handbook section contains the latest data concerning conductors and insulators. It includes a map of the completed grid in Great Britain and a list of overseas telephone routes and rates. The alphabetical, geographical, colonial and foreign sections contain information in a convenient form which would be difficult to find elsewhere.

The British Polar Year Expedition to Fort Rae, North-West Canada, 1932-33

By J. M. STAGG

THOUGH the special and continuous needs of meteorology, terrestrial magnetism and allied sciences for systematic observations over wide areas and in high latitudes had been felt long before 1882–83, it was not until then that a large-scale effort was made by twelve countries to study events in those subjects through a full year according to an agreed plan. In collaboration with Canada, Britain's share in that First International Polar Year, as the twelve months ending August 1883 has come to be called, was to equip a party under Capt. Dawson, R.E., for continuous observations in meteorology, terrestrial magnetism and aurora to be carried out at Fort Rae, a trading outpost of the Hudson's Bay Company on the Great Slave Lake, North-West Canada. Practically and scientifically, from the point of view of international collaboration as well as that of Britain's own participation in it, the year's activities were completely successful.

As the jubilee of that First Polar Year approached, it was felt in many quarters that no time could be more appropriate for a repetition on a much more extensive and intensive basis. In the three primary subjects then investigated, advances in recent years have been large, and mainly all in the direction of indicating that further progress depended on the gathering of more precise observational material from a still wider field and to the limits of the atmosphere. The sequences of weather changes over limited regions like Britain in moderate latitudes might well be determined by conditions in the stratosphere far to the north or south, days or weeks ahead : the short-period irregular changes in the earth's magnetic field, known to be intimately associated with the state of ionisation in the conducting layers of the high atmosphere, seemed to be bound up with auroral activity on one hand and the interruption of long-distance wireless communication on the other. To a few even it has seemed not improbable that these two domains, the apparently locally determined meteorology and the more cosmically produced aurora and its effect on the earth's magnetic field through the intermediary of the ionosphere, might be interconnected. Such were the questions : in many cases speculation and theory had outstripped fact.

So in 1929 the time was ripe for the proposal of a Second Polar Year for 1932–33. An International Polar Year Commission was set up with the directors of the meteorological services of many countries as members and Dr. la Cour of Copenhagen as its president. National committees were constituted to carry out the general recommendations in each country. In Britain, with Sir Henry Lyons as its chairman, and Dr. G. C. Simpson as secretary, the National Polar Year Committee has had representatives from the Royal Societies of London and Edinburgh and from six other interested institutions. A grant-in-aid of £10,000 by the Government through the Air Ministry has been the primary source of supply for the Committee's activities, though many manufacturing and wholesale firms have contributed to the fund by generous gifts of food and instrumental equipment and even of money.

Britain's share in the international programme has been fourfold :

(1) The provision of new instruments and facilities for conforming to the general plan of observations at some permanent meteorological stations and observatories in the country as well as on ships at sea.

(2) An intensified programme of auroral observations and photography in Scotland and in the Orkney and Shetland Islands.

(3) An extensive and novel series of observations on the variation in height and intensity of ionisation of the conducting layers in the high atmosphere, by Prof. E. V. Appleton and his party at Tromsø.

(4) The equipment and manning of a station at Fort Rae, Canada, for complete and continuous observations in meteorology, terrestrial magnetism, aurora and atmospheric electricity.

The Fort Rae party under J. M. Stagg comprised Messrs. W. R. Morgans, P. A. Sheppard, and W. A. Grinsted (Meteorological Office) with Mr. A. Stephenson (Cambridge) as observers, and Mr. J. L. Kennedy as mechanic and steward. With sixteen tons of instrumental and foodstuff equipment, the party left England in May 1932 and journeyed by the usual route to Edmonton, Alberta, thence northerly for about a thousand miles, using the Hudson's Bay Company's river transport for the trip down the Athabasca and Slave Rivers, and so across the Great Slave Lake to its northern extremity. The site of the station was reached by the middle of June.

To ensure that all the instrumental equipment would be in full running order and the routine of observation thoroughly established by August 1, the starting date for the overlapping 'year' of thirteen months, every minute before then was required for erecting special huts and getting the autographic recording instruments in action. These covered every one of the main aspects of meteorology and terrestrial magnetism, and included a new type of magnetograph designed at Copenhagen, in which the variometers for the force components were optically compensated for temperature changes, and with a recorder arranged so that the time of incidence of sudden changes in the magnetic field could be read with an accuracy of two seconds. It is of interest to note that, using this magnetograph, a 'sudden commence-

ment' of a magnetic disturbance on April 30, 1933, was judged to appear practically simultaneously at places so far apart as Copenhagen, Thule (in north-west Greenland) and Fort Rae.

Nearly all recording instruments were run in duplicate to make sure that the records would be as complete as possible, the secondary records in most cases providing the additional safeguards of furnishing data with other characteristics, as, for example, a more open time-scale or lower sensitivity.

As part of the programme of meteorological work, more than four hundred pilot balloon ascents were made during the term of occupation of the station and twenty-eight *ballons sondes* were sent up. The hydrogen for this work was manufactured on the spot in a new apparatus designed at the Airship Works, Cardington, and was produced by the interaction of granulated silicon with heated caustic soda. Two of the instruments from *ballons sondes* released in winter with surface temperatures about –30°C. attained heights of 16 km. In both cases, the base of the stratosphere was very well marked at 8·5 km. and with temperatures about –60°C.

With Fort Rae in an exceptionally good position relative to the zone of maximum auroral frequency, much importance was attached to the observations and photography of aurora for precise determinations of its height and orientation. To a substation (which was actually the site of the station in the First Polar Year fifty years ago) some 25 km. to the south-east, a telephone line was erected allowing photographs of the aurora to be taken simultaneously by cameras specially designed for auroral work in Norway. From these pairs of photographs, some 4,700 of which were taken by the party during the stay at Rae, it is hoped to obtain much definite information about aurora in that part of Canada. Although the period was so near the minimum of the present cycle of solar activity, aurora was observed at some time on every night when conditions were practicable. It was not infrequent during the winter months for aurora to continue almost uninterruptedly for fifteen hours.

In addition to the activities in these, the main lines of investigation, observations in atmospheric electricity claimed much attention. Continuous records of the potential gradient of the earth's electric field near the surface were maintained autographically, and frequent measurements of air-earth current and small ion content of the air were made. Experiments were also carried out to determine the nature of the diurnal variation of these quantities and also of the rate of production of ions near the ground.

The winter conditions at Rae during 1932–33 were characterised more by the steadiness of the cold than by extremes of temperature reached. Over the seven months ending April 30, 1933, the average temperature was –20°C., but the lowest average for any single month was only –31°C.—January and February were almost the same in this—and the lowest daily mean was only –40°C. During the short warm summer, daily temperatures frequently exceeded 20°C.

The party returned from Rae in September and early October 1933 with a very large amount of observational matter for further study. It is now the intention that each country participating in the international programme should make all its data available by reduction and publication as early as possible, so that the larger and more important task of co-ordination of the results from all the stations may not be delayed. In many ways it was unfortunate that the Second Polar Year should have coincided with times of such grave financial stringencies in so many countries. But the difficulties encountered in the preparations both by the International Commission responsible for the general organisation of the Polar Year activities and by the individual national committees in each country served to emphasise the value of the work. It is certainly illuminating that forty-six different countries have taken part in the programme in one way or another, and of these, twenty-three have set up extra stations—in many cases more than one—either within their own territory to extend the number of their regular observatories, or outside their own lands as temporary observation posts.

Progress of Industrial Research

In a recent address Dr. F. A. Freeth made an eloquent protest against the habit in Great Britain of always classifying science as something apart from ordinary life. It would be difficult to imagine a document better fitted to demonstrate the essential place of science in our ordinary everyday life, or to inspire a general confidence in scientific workers and science by the public, than the eighteenth annual report of the Department of Scientific and Industrial Research.* Published within a couple of days of Dr. Freeth's address, the report describes contributions made by the work of the Department to every major need of our social and industrial life. The comparatively small sum of £654,736 (gross) or £451,987 (net), which represents the expenditure of this Department for the year ending March 31, 1933, represents also a contribution to the efficiency of every department of State and to the recovery or the prosperity of many industries, the true value of which it is impossible to assess in cash, but which repeatedly has earned dividends many hundredfold on the expenditure involved.

Even this expenditure, however, represents a further decrease on that recorded in the previous

* Department of Scientific and Industrial Research. Report for the Year 1932–33. (Cmd. 4483.) Pp. iv+189. (London: H.M. Stationery Office, 1934.) 3*s*. net.

report—£695,677, the actual expenditure in 1931–2 being £543,700. Receipts, however, increased from £160,977 to £202,749, thus exceeding those of 1930–31 (£184,829). Expenditure on the National Physical Laboratory was £195,316, against which receipts amounted to £90,854; on the Chemical Research Laboratory, £18,406 net; Forest Products Research, £32,286 net; Fuel Research, £84,226 net; Radio Research, £11,340 net; water pollution, £8,642 net and Headquarters Administration, £24,791 net. Against expenditure of £44,583 on Food Research, a grant in aid of £30,133 from the Empire Marketing Board assisted to bring the net expenditure to £10,774. Receipts of £7,380 bring the expenditure on Building Research to £34,663 net, while the £46,140 balance of the Million Fund brought the Grants for Research to a total of £51,700 net.

A large part of the report of the Advisory Council, over Lord Rutherford's signature, which precedes the summary of work, is devoted to a discussion of the 'million fund' to which reference has already been made in NATURE of January 20, p. 77. The same report, however, also refers to the transference to the Department from the Ministry of Transport of the responsibility for the direction and supervision of road research. This is a matter of direct concern to every citizen whether he uses the roads in his own car or in public vehicles. The traditional methods of road-making were designed to provide a surface sufficiently firm to prevent slow-moving horse-traffic from sinking appreciably in wet weather. Despite the revolutionary changes which have taken place with surprising success in the last thirty years, we have still very little scientific knowledge either of the foundations of the road or of the materials of its superstructure such as will ensure that a success in one place can be repeated in another. A systematic programme of research has been prepared, covering not only the testing of the materials but also the processes involved in road construction, maintenance and use. One of the most important requirements for success in laboratory investigations is correlation between behaviour in practice and the results of laboratory tests. Such correlation in road work is a protracted process, as the information from practice is obtained only after the road has been in existence many years. Results from road tests at the Harmsworth Experimental Station, for example, are incomplete after 3½ years of heavy traffic, and to accelerate progress attention is being given to the development of road-testing machines.

Other work bearing on transport is also being carried out by the Department. The Chemical Research Laboratory is investigating the properties of road tar, while investigations to discover the most suitable traffic signal beams have been carried out at the National Physical Laboratory, the results of which, after tests on signals in actual use at Reading and in Oxford Street, London, have been embodied in a British Standards specification. Other work at the National Physical Laboratory on motor-car headlights has led to a method of determining the light distribution which should be aimed at for a headlight beam.

The National Physical Laboratory has also been concerned with other methods of transport. Its Aerodynamics Department has been responsible for much important work bearing on the design of new types of aeroplane and particularly on stability and control of aeroplanes, including an investigation on the spinning properties of typical aeroplanes. The corrosion fatigue of certain aircraft materials has been studied by the Engineering Department, the Sound Division has rendered assistance in connexion with the acoustical features of aircraft design. The recent series of aviation disasters alone should indicate the great importance of work on systems of direction-finding which is proceeding under the Radio Research Board.

Research on the design of hulls and propellers for ships carried out on models at the William Froude Laboratory, dealing with the influence of waves on the resistance, propulsion and pitching of ships has reached a stage when the general effects of rough water upon the hull resistance are known. Such progress has been made with the study of the action of a screw-propeller when propelling a ship in a rough sea that performance can be predicted with confidence from model tests. In addition, investigations have been carried out to determine the effect of wind forces from any direction on the steering of ships.

Particular stress is laid on timber research in the Report of the Advisory Council. The work carried out in the Forest Products Research Laboratory covers the working and finishing properties of wood, as well as its natural durability and its resistance to insect or fungus attack, which is of widespread importance to the builder of houses or maker of furniture, etc. It is, however, only one link in a chain which connects the forest in the Empire Overseas with the timber user in Great Britain. The other two links, information on prices and supplies and marketing promotion, are seriously threatened by the disappearance of the Empire Marketing Board, and upon their continuance much of the utility of the research on timber depends.

Timber naturally suggests building, and the work of the Building Research Station provides many illustrations of the influence of scientific research on the comfort and efficiency of the home. These include investigations on factors influencing weathering, a study of the most economical means of heating a house, which indicated the superiority of the intermittent method, investigations on plasters, on the problem of damp walls, the exclusion of solar heat by thin roofs, on painting on cement and plaster. Other contributions in this field come from the work of the Research Associations. Such, for example, are those dealing with frost-bursting of water-pipes of various materials, with methods for preventing the corrosion of galvanised hot-water tanks or the dulling of bright metal surfaces used in architecture, both inside

and outside buildings. Investigations on earthing to eliminate risks of electrical shock have continued: a comprehensive survey of causes of radio interference due to the operation of electrical equipment is proceeding, while at the National Physical Laboratory the transmission of sound through partitions or double windows is receiving attention with a view to better design of rooms and houses, nor should we overlook the work which is being carried out on steel frame buildings.

A method of determining the efficiency of hot plates is being standardised, and the discovery of a means for reducing the temperatures reached by gas-filled lamps in show-case and shop-window fittings has definitely reduced the risk of fire in stores where inflammable goods are displayed.

So much of the work of the Department has a direct bearing on public safety and health that its activities can quite legitimately be summarised as that of a great national life assurance department. In addition to the industrial examples already given, space allows us to mention only two: the metallurgical research dealing with the factors causing the cracking of boiler plates and the work carried out on the production of a more efficient respirator for use in industrial processes as a protection against the inhalation of dust. From a more general point of view may be cited the search of the Chemical Research Laboratory for new drugs efficacious in the treatment of sleeping sickness in Africa, or the work on atmospheric pollution and water pollution.

Such a dry year as 1933 emphasises the importance of the latter field, and the report itself points out that two recent serious outbreaks of enteric fever in Yorkshire were both due to comtaminated water supplies. Frequently the condition of streams and rivers cannot be improved sufficiently until satisfactory methods of reducing the amount or polluting nature of various domestic or trade effluents have been devised. Since new types and sources of pollution are always arising, as, for example, the effluents from modern milk depots or factories, the department concerned is continually charged with fresh programmes for investigation.

The whole of the important food investigations carried out under the Department have a profound bearing on the national health. The quality of foodstuffs is continually being improved and waste eliminated by means of better methods of transport and storage. One effect of such work is to make possible a steadily rising standard of living. The Food Investigation Board has been responsible for work covering the storage of meat by freezing or chilling, the transport of bacon from Australia and New Zealand, the freezing and smoke-curing of fish, the gas-storage of apples, the storage of fruit for canning, and much effort is being given to the development of appropriate methods of studying the damage which fungi, etc., can produce in fruit and other foodstuffs. The Flour Millers' Research Association has undertaken investigations designed to place the conditioning of flour on a scientific basis and is studying the effect of added oils and fats on the baking quality of the flour. The Cocoa, Chocolate, Confectionery and Jam Trade Research Association has materially assisted in improving the making of marmalade, jams and jellies by its study of pectins, and has studied the development of means of combating insect pests of nuts and chocolates and other confectionery in retail shops and of remedying defects which develop in chocolate-covered wafers and candied peel. An outstanding investigation of the Food Manufacturers' Research Association has been the development of an instrument for determining the amount of salt in any part of a piece of meat during curing, and in consequence allowing of closer control of the process.

Some will be surprised to learn that important dental research is being carried out under the Department, including the determination of the best composition of amalgams for dental purposes and the properties of widely-used dental rubbers, or that as a result of studies on aluminium paint made by the Paint, Colour and Varnish Manufacturers' Research Association it is possible to indicate the conditions which must be observed to avoid the loss of brilliance or other special properties.

The relation of such research associations as those of the cotton, woollen and linen industries, or the Launderers' Research Association to our everyday needs is equally impressive. The first, for example, has provided the industry with a new method for the rapid separation of good cotton from dust and other foreign matter. The second has developed a method for treating the fibres in bulk before spinning, whether for woollen or worsted processes, which renders them unshrinkable, besides giving lustre and softer handling, thus eliminating the prickly feeling which sometimes causes discomfort in wearing woollen goods. The same Association is developing reliable scientific tests for judging the fastness of dyed woollen fabrics to light and other agencies.

The Linen Research Association has not only established the causes of the comparatively rapid wear of double damask on laundering along lines near the selvedges but has also found a method modifying the cloth structure so as to enable it to withstand the laundry wear. The Launderers' Research Association has been responsible for tracing the cause of the development of holes in collars for which ordinary wear could not account and, as a sequel, for co-operation with the manufacturers to eliminate the defect. Moreover, the arrangement by which certain manufacturers have agreed to submit new fabrics to the Association for examination of the laundering properties before putting them on the market is one the importance of which to the public is obvious.

Through the work of the Department, science is contributing not merely to industrial efficiency and safety, to public health and safety and social welfare, but also to a steady rise in the general standard of living and in the quality of the service rendered by our interdependent industries.

Obituary

Prof. Davidson Black, F.R.S.

THE untimely death of Prof. Davidson Black, which occurred on March 15 at the age of forty-nine years, deprives the Cenozoic Laboratory of Peking of its honorary director, who had unique qualifications of knowledge, temperament and technical training to make him the ideal man for such a position. Not only had he in high degree the competence and personal qualities for the work, but he also had the enterprise and courage boldly to pursue the adventurous policy which has met with such conspicuous success. When he entered the University of Toronto, Prof. A. B. Macallum recommended him before entering the Faculty of Medicine to acquire some general training. Acting on this suggestion, Davidson Black studied anthropology and took an arts degree. After qualifying in medicine he became instructor in anatomy in the Medical School of the Western Reserve University at Cleveland, Ohio. At the end of 1913 he was made assistant professor of anatomy under Prof. Wingate Todd, and after his marriage he came to England and worked at comparative neurology in my department in the University of Manchester.

At that time I was working on the reconstruction of the Piltdown skull and the study of the endocranial cast obtained from it, and for purpose of comparison had collected casts of all the known fossil human skulls. This work aroused a much greater interest in Dr. Davidson Black than the brains of the Dipnoi in which I was trying to engage his interest, and he at once made himself familiar with all of the material I had collected, and informed me that that was the kind of work to which he was determined to devote his life. He at once set to work to train himself for such a career, acquiring the technical experience and studying the geological literature which was essential for the field work he contemplated. His attention was arrested by the writings of a fellow Canadian, Dr. William D. Matthew, at that time a member of the staff of the American Museum of Natural History in New York. In particular he was fascinated by the work entitled "Climate and Evolution" which was published in the *Annals of the New York Academy of Sciences*, and this gave Davidson Black the complete conviction that China was the place where primitive man was likely to be discovered. Hence in 1916 when, after his military service, he was offered the position of professor of neurology in the Peking Union Medical College, he at once accepted the offer under the conviction that it coincided with the ideas he had formed as to his career.

In Peking, Davidson Black found a group of very agreeable colleagues with whom he entered into relationships of close friendship, in particular with Dr. A. W. Grabau, the professor of palæontology in the National University of Peking, who was destined later on to suggest the name *Sinanthropus pekinensis* which Davidson Black adopted for his great discovery. To the group of young geologists in Peking, Grabau was the guide and friend. His delightful dinner parties served the purpose of keeping this group *au courant* with progress of geological knowledge, and also gave them perspective and a wide outlook upon the subject. In the course of the conversations which took place at these dinner parties, Davidson Black learned of the observation made by Prof. Schlosser in 1903 of the discovery near Peking of an intriguing tooth which might be that of a primitive man. This served still more to deepen his conviction that Peking was the promised land of his ambition.

When, in 1926, Dr. Gunnar Anderson announced that the expedition working under his direction had found an early Pleistocene tooth, a discussion arose as to whether or not it was human. Its finder was indignant that the newspapers referred to it as the "Peking Man". Dr. Davidson Black did not hesitate. He regarded it as a definite confirmation of the hopes aroused by the writings of Matthew and Schlosser as to the early man he had gone to China to discover. In 1927 he published (in *Palæontologia Sinica*) a detailed description of the tooth which Dr. Bohlin had found, and on the basis of the evidence he cited he founded the new genus and species for which, on the suggestion of Prof. Grabau, he applied the name *Sinanthropus pekinensis*.

The severe criticism to which Davidson Black was exposed had no other effect upon him than to make him redouble his efforts to establish the proof of the claim he had put forward, and to intensify the search for fresh material. He had a little brass case made to contain this tooth which he attached to his watch chain, and he made a tour of the world trying to enlist the support of the palæontologists of Europe and America for the new genus he had created on the evidence of the tooth. The excavations which were carried on at Chou Kou Tien under his direction resulted in 1928 in the discovery by Dr. Birger Bohlin, working in conjunction with the Chinese geologists Dr. C. C. Young and Mr. W. C. Pei, of fragments of two jaws in association with pieces of brain cases, and the evidence confirmed the validity of the genus founded on the basis of the tooth in 1927.

The importance of the work accomplished during the two years covered by the first appropriation of the Rockefeller Foundation led in 1929 to the renewal of the grant and the creation of a special department, the Cenozoic Research Laboratory of the Geological Survey of China, under the honorary directorship of Prof. Davidson Black. This significant action was due in large measure to the support of Mr. Roger Greene, the executive head of the Peking Union Medical College, of which Dr. Black was professor of anatomy. The work of developing these fossils was carried out by Davidson Black himself with superb technical skill. Not

only did he clean the fossils and photograph them himself, but also he made the excellent casts which have enabled workers in Europe, who could not see the fossils themselves, to form a very exact idea of their nature. The attainment of these successful results implied a very happy spirit of friendship in the team of workers who undertook the various tasks, and called for all the unselfishness and spirit of conciliation which were so conspicuous in Dr. Davidson Black, and without which the spirit of harmonious co-operation would have been impossible. He was always very jealous of the honour of his collaborators, especially of the Chinese geologists. When, in 1929, the Geological Society of China created the Grabau Gold Medal to be awarded for distinguished work, and recommended him for the first award, he protested that it should go to Dr. Grabau's pupil Pei, who had made the great discoveries. Greatly as he appreciated the distinction, which was made doubly attractive by being associated with his old friend and master Grabau, he felt very strongly that the leader of the field work who had found the fossils would be the more appropriate recipient. The Society, however, wisely thought better, and solved the difficulty by awarding another gold medal to Mr. Pei. This incident, however, was typical of his attitude towards all his Chinese colleagues, and explains a great deal of the conspicuous success of the Cenozoic Laboratory.

Dr. Davidson Black's genius for friendship really lies at the back of the great work he has been carrying on. He was a man of charming personality, of great generosity and modesty. He was as enterprising and resourceful in superintending a children's party as he was in directing the excavations at Chou Kou Tien. It was a source of intense satisfaction to him when he was invited by the Royal Society to deliver the Croonian Lecture in 1932. It was not so much any pride in receiving this high distinction, as the opportunity it gave him to describe the work in Peking in his own restrained and careful way, and particularly the opportunity it offered of making adequate acknowledgment of the help he had received from others, in particular his colleagues in Peking ; and when in the following year he was elected to the fellowship of the Royal Society, he received this distinction with the same modesty. These genial qualities earned him the friendship of a wide circle of people of all nationalities in Peking, who are now mourning their great loss.

Prof. Davidson Black's methods of work were peculiar in many respects. All his serious work was done at night-time for the sake of the quiet and the freedom from disturbance which it brought. He was fortunate in having the complete confidence and support of the Rockefeller Foundation of New York, which fully realised its great good fortune in having in its service so conspicuously competent a man. With its backing, Davidson Black was looking forward to a long life-time of investigation. On his way to England two years ago to deliver his Croonian lecture, he made an extended reconnaissance in India, Persia, Western Asia and Egypt to discover likely sites on which to carry out excavations for fossils of men and apes ; and for several years he has lived in the hope of exploring the Sinkiang Province of Chinese Turkestan, in the conviction that he would there find fossil apes more nearly akin to man than anything that is yet known. In fact his life was devoted to the study of Central Asia, in the hope that the geographical knowledge he acquired would prove of use to him for realising his hopes. He always kept by his bedside the lives of Genghis Khan and Tamerlane written a few years ago by Harold Lamb. By saturating himself with these works he felt he was becoming acquainted with the part of the world in which his chief hopes were centred.

In taking farewell of Davidson Black one regrets not only the loss of a friend of particular charm and generosity, but also the cutting short of the brilliant work in which he was engaged, and which there is no one else competent to complete.

G. Elliot Smith.

Prof. D. M. Y. Sommerville

Duncan McLaren Young Sommerville was born in 1879 in Rajputana, and died on January 31, 1934, in New Zealand. After receiving an early education at Perth Academy he went to the University of St. Andrews, where his mathematical and scientific ability soon became apparent. In 1905 he was appointed lecturer in the Mathematics Department at St. Andrews, a post which he filled until 1915, when he became professor of pure and applied mathematics in Victoria University College, Wellington, New Zealand.

While Sommerville was essentially a geometer he had considerable interests in other sciences ; and it is noteworthy that the classes which he chose to attend in his fourth year of study at St. Andrews had been in anatomy and chemistry. Crystallography in particular appealed to him ; and doubtless these possible outlets influenced his geometrical concepts and led Sommerville to ponder over space-filling figures, and gave an early impetus to thoughts in a field which he made peculiarly his own. Beneath his outward shyness considerable talents lay concealed : his intellectual grasp of geometry was balanced by a deftness in making models, and on the æsthetic side by an undoubted talent with the brush. In the course of years he produced a pleasing collection of water colour sketches of New Zealand scenery.

Sommerville's mathematical work falls naturally into two parts : that of the teacher and that of the original investigator. His textbooks, which have appeared at regular intervals, are a valuable link between the old and the new era in the teaching of geometry at college. They are the "Elements of Non-Euclidean Geometry" (1914), "Analytical Conics" (1924), "Introduction to the Geometry of n Dimensions" (1929), and the recent "Three Dimensional Geometry" (1934), the appearance of which he did not live to see. All

are characterised by a variety of algebraic treatment and a wealth of illustrations and examples, but nowhere does technical manipulation outrun the geometry. The first of these, a provocative little book, appeared at a time when metrical systems alternative to that of Euclid were known only to the few. It is not surprising that such a teacher carried throughout his life the esteem and appreciation of his students. One of his most distinguished pupils, A. C. Aitken, writes of the critical time in his own student days when the University of Otago was temporarily without a professor of mathematics, and how willingly Sommerville filled the gap by weekly correspondence. The written solutions and comments went far beyond what was necessary for mere elucidation.

Beginning in 1905, Sommerville wrote more than thirty original papers and notes which have been published in well-known journals at home and abroad. The first, entitled "Networks of the Plane in Absolute Geometry" (*Proc. Roy. Soc. Edinburgh*, 25) is typical of the sequel. The main theme is that of combinatory geometry, exemplified by a systematic investigation of "The Division of Space by Congruent Triangles and Tetrahedra" (1923) in the same journal, and extended to n dimensions (Palermo, 48, 9–22; 1924). Out of this grew the work upon the relations connecting angle sum and the volume of a polytope in space of n dimensions (*Proc. Roy. Soc. London*, 1927).

Sommerville was ever ready to apply his special gifts to unusual examples, as in his analysis of preferential voting and a highly original treatment of the musical scale. He was also much interested in astronomy, and was one of the founders of the New Zealand Astronomical Society and its first secretary. At the Adelaide meeting of the Australasian Association for the Advancement of Science held in 1924 he was president of Section A. His was a life of unsparing activity, and the fruits of his work will abide. There has passed from Scotland one who had already become her leading geometer of the present century.

H. W. TURNBULL.

WE regret to announce the following deaths:

Dr. James Mackintosh Bell, O.B.E., formerly of the Canadian Geological Survey, and in 1905–1911 director of the Geological Survey of New Zealand, on March 31, aged fifty-six years.

Dr. James Munsie Bell, dean of the School of Applied Science in the University of North Carolina, who has carried out important researches in physical chemistry, on March 3, aged fifty-three years.

Prof. Arthur Ranum, professor of mathematics at Cornell University, on February 28, aged sixty-three years.

News and Views

Caleb Whitefoord, F.R.S. (1734–1810)

CALEB WHITEFOORD, friend of Benjamin Franklin in the hey-day of the latter's fame, was born in 1734, at Edinburgh (the exact date would seem to be unrecorded). Whitefoord was the natural son of Col. Charles Whitefoord, himself the third son of Sir Adam Whitefoord, Bt., of the shire of Ayr. He died on February 4, 1810, at his home in Argyle Street, in the vicinity of Soho, and was buried in Paddington Churchyard. Graduating at the University of Edinburgh, Whitefoord sought London as the best field for the exercise of his varied gifts, chief among these being a faculty for satirical journalism. Eventually there were few literary, scientific and political celebrities of his period outside his circle. Intimacy with Franklin (they were then neighbours in Craven Street, Strand) led to the opinion that Whitefoord would make an eligible diplomatic agent for the purpose of assisting in the restoration of peace with America. Accordingly, he became secretary to the Commission which concluded peace with the United States at Paris, in 1782. He was elected a fellow of the Royal Society on June 24, 1784, when Sir Joseph Banks was president. A fellow of the Royal Society of Edinburgh, and of the Society of Antiquaries, London, he was a vice-president of the Society of Arts, and a member of the Philosophical Society of Philadelphia. Whitefoord's portrait was painted by Sir Joshua Reynolds in the eventful year 1782, and hangs in the National Portrait Gallery; a mezzotint of this by S. W. Reynolds is prized. A pleasing drawing (head and bust), by R. Cosway, is reproduced in the *European Magazine* for 1810. In 1790 Whitefoord presented a fine portrait of Benjamin Franklin, by Joseph Wright, to the Royal Society. Such interesting connexion with the Society is further emphasised by the circumstance that Whitefoord, with Count Rumford, signed, in 1801, the certificate of recommendation for the election of Warren Hastings.

Industrial Research and the State

MR. STANLEY BALDWIN, as Lord President of the Council, may be regarded as a Minister of Research, since he is responsible to Parliament for the Committee of the Privy Council for Scientific and Industrial Research. He is keenly alive to the possibilities of scientific and industrial research, and this attitude marks the message he sent recently to the conference of industrial research associations, reference to which was made in NATURE of March 31, p. 504. Mr. Baldwin confirmed his promise on behalf of the Government in replying to a question in the House of Commons on March 27, when he said:

"ABOUT two years ago, steps were taken by the Department of Scientific and Industrial Research to ascertain the views of the Councils of Research Associations connected with the Department on a

proposal that powers should be obtained to require firms in an industry to contribute towards co-operative research where the large bulk of the industry was in favour of such a course. The result was unfavourable to the proposal. Evidence has, however, been received that there may have been some change of opinion in the interval and the Department propose to consult the Associations again on the subject. If it appears that there is now a consensus of opinion in favour of such a Bill and if it is the opinion that a levy for research would be found practicable in a sufficient number of cases and that advantage is likely to be taken fairly generally of the provisions of such a Bill, . . . the whole matter will receive sympathetic consideration by the Government."

This reply is encouraging, and has an important bearing on the investigations undertaken by a Joint Committee of the British Science Guild and Association of Scientific Workers as to whether the research associations should be financed by a levy on the industries concerned, or by a State grant for a limited number of years of a sum of money designed to form an endowed capital for research—such grants to be provided from the new revenue from tariffs, wireless licences or other sources.

The Panda or Cat-Bear

The arrival at the Gardens of the Zoological Society of London of three specimens of that rare and most interesting animal the panda, or 'cat-bear' (*Aelurus fulgens*), should form an addition of no small interest to those visiting the Gardens during the summer months. The coloration of this animal is striking. The fur is of a rich chestnut-red, with white markings on the head, and black rings round the conspicuously long tail, while the under parts are almost black instead of the normal white. Though strictly speaking a carnivore, it is nevertheless almost omnivorous. For while small mammals and birds, eggs, insects and their larvæ form their principal diet, they also feed largely on fruit and many kinds of shoots, especially of the bamboo, of which they are said to be very fond. Having regard to their typically carnivorous dentition, this very mixed diet is noteworthy.

The present geographical distribution of the panda is restricted to the Himalayas from Nepal to Yunnan, at an elevation of 6,000–11,000 ft., where they haunt trees or hide among boulders as circumstances determine, emerging in the early morning and evening to forage for food. Not much is known of their habits, as may be imagined from their almost inaccessible haunts, but observations on captive specimens have revealed some interesting facts, especially in regard to their mode of sleeping. Thus at times they will curl up like a cat, turning the long tail over the head ; and at times they are said to sleep standing, with the head turned downwards between the forelegs after the manner of their near relations the racoons. When excited they emit a strong odour of musk. The panda is evidently a species which is dying out, for its range in past times was vastly greater. This much is shown by the fact that a panda one and a half times larger than the existing species has been found in the English Pliocene. No fossil remains of pandas have yet been found in America. But having regard to its very near kinship with the racoons, they may yet be found.

Cane-Rats

Another addition to the Zoo worthy of note is three young cane-rats (*Aulacodus swinderianus*) from West Africa. These animals attain a considerable size when adult, the body measuring nearly two feet in length, exclusive of the tail, and weigh as much as 10 lb. They range from the Sudan to the Cape, and up the west coast as far as Sierra Leone. The fur is conspicuously bristly, speckled with yellow and brown. The incisor teeth are of great size and very powerful. The upper pair are marked by three vertical grooves, sufficiently deep to leave their mark on anything gnawed by these animals. They feed on roots and shoots, and sugar-cane where it is to be had.

Archæological Studies in Peru

It would appear that the celebration, or rather the 'commemoration', to use the term preferred locally, of the fourth centenary of the Spanish capture of Cuzco, the capital of the Inca empire of Peru, has given rise to a wave of popular enthusiasm for archæology which has taken the practical form of a vote of £30,000 (according to a dispatch in the *Times* of March 27) to be expended on, *inter alia*, the establishment of an archæological institute for the study and display of Peruvian antiquities and on archæological exploration and research. Already substantial discoveries have been made in the excavation of Sachsahuaman, a site near Cuzco, where hundreds of workmen are engaged in uncovering the walls, buildings, conduits, etc., in beautifully hewn stone of this once important fortress, which has been pronounced to be the "most wonderful achievement of ancient man in the two Americas". Excavations have also been begun at Tambo-machal and Pisac, and are in contemplation at Ollantaytambo and Macchu Picchu, the last stronghold of Inca power. These operations are under the supervision of the Director General of the National Museum and are being conducted in accordance with the principles of scientific archæological research. Even at this early stage, attention has been directed to the problem of pre-Inca civilisation and the opportunities which it offers for investigation. Happily the foundations for its study on scientific lines have been laid down by the work of Prof. Max Uhle and others, and if funds which hitherto have been lacking for extended exploration are now to be available, many vexed and obscure problems of Central and South American archæology will come under review. The presence of a number of distinguished archæologists in Peru during the celebrations, which began on March 23 and will go on until July 18, will no doubt guide, as well as stimulate, local effort, which is inspired by motives not entirely unmixed. Even in Peru, archæology is not immune from the spur of over-enthusiastic nationalism.

Anthropological Studies in India

IN view of the important part which will be played by racial, religious and social questions in relation to administration and government in the India of the future, considerable interest is attached to a brief survey of the work in anthropology which has been, and is now being, done in India by Rai Bahadur L. K. Ananthakrishna Iyer, chairman of the Board of Higher Studies in Anthropology of the University of Calcutta and the author of a number of well-known works on Indian anthropology, which appears in *Current Science* of January 1934. He points out that it is only in the last fifteen years that the vast mass of anthropological material offered by India has begun to be utilised systematically. The School of Anthropology in the University of Calcutta was organised in 1921, and the University is now unique in prescribing the subject for the M.A. and M.Sc. examinations. The students also have the advantage of an annual course of practical instruction in the field in various parts of Bengal and Chota Nagpur, when both anthropometry and cultural anthropology are studied.

THE anthropological work of the University is supplemented in Calcutta by that of the Indian Museum, where there is a well-equipped laboratory, and research work is also carried on. Much of this research has already been embodied in important monographs. Reference is also made to the work of Dr. J. H. Hutton in Assam and to that of Sarat Chandra Roy, editor of "Man in India". On the west coast, the only institution concerned with anthropology is the Anthropological Society of Bombay ; and the author expresses regret that Madras, with one old and two infant universities, has taken so little advantage of its opportunities for anthropological research. In Mysore, the University has revived the Ethnographic Survey of the State, and the fourth and final volume of its report is now in preparation for publication. The work of the Indian Science Congress is also noted. The author concludes by deploring the fact that while there are many regions in India unexplored anthropologically, the workers are few. He urges that a band of young men should be trained to collect material in these unexplored fields.

Agricultural Education in New Zealand

AGRICULTURAL research in New Zealand has a staunch friend in the Governor-General, Lord Bledisloe, who, having a lifelong acquaintance with British agriculture, is peculiarly fitted to estimate the value to the farming community of such agencies as the New Zealand Department of Scientific and Industrial Research and the Cawthron Institute. In a recent address to the students of Wellington College, New Zealand, on the new needs of education, he referred to the appointment of a former student, Theodore Rigg, to the directorship of the Institute, "an organization notable throughout the Empire for the thoroughness, accuracy, and economic value of its agricultural researches". Touching on the question of the careers for which a college training offers a suitable preparation, he stressed the claims of the rural population of a Dominion in which farming is the greatest industry to leadership such as a college graduate might aspire to. He added point to his observations by revealing that it was considerations such as these which induced the Rhodes scholarship selection committee to select, for the first time in the history of the Trust, a young agricultural scientific worker for appointment to one of these scholarships.

Investigations in the Stratosphere

THERE are now two bodies in Russia intent on surveying the scientific and other possibilities of the upper atmosphere. They are the Society for Aviation and Chemical Warfare, with outside experts and with M. Dubenski, assistant director of the Military Aviation Academy, as chairman of the commission, and a more civilian type of composite body drawn from the Leningrad Institute of Aerology, the Radio Institute and the Central Geophysical Laboratory. The former organisation was responsible for the successful flight of *Stratostat USSR*, piloted by M. Prokofiev last September, as well as that ending in disaster on January 30 this year. If one can judge from the reports from Russian newspapers, these two schools are sharply divided on the question of manned and unmanned balloons respectively. The military organisation, the programme of which is the study of ultra-violet solar radiation and atomic disintegration by cosmic rays, is concentrating its attention on shock-absorbers, gliders, parachutes, etc., in order to safeguard future crews from disaster. The civil body, however, is specialising upon further improvements in automatic registering devices to be attached to balloonets after the manner of Regener's, whose work with these down to a pressure of 22 mm. (about 28 kilometres up) has not yet been superseded. The new device consists of a string of two or three such elastic balloonets each about 2 metres in diameter on the ground, filled with hydrogen for carrying the self-recording devices. A trial has already been made with one such balloonet. This reached a maximum altitude of 18·6 kilometres and was followed during its ascent by theodolite observations. It automatically transmitted radio signals of pressure, temperature and hygrometric data on a wave-length of 25 metres. Unfortunately, the apparatus has been lost. In a new apparatus which was to be ready by the end of March, there were to be added cosmic ray intensity and gas analysis transmissions and a camera. This work of the Institute of Aerology is a very laudable enterprise and the results will be awaited with interest.

Sydney Harbour Bridge

AMONG the recently published abstracts of papers to be discussed by the Institution of Civil Engineers are four relating to the design, construction and calculations of the great arch bridge over the harbour at Sydney, New South Wales. The papers, Nos. 4904, 4922, 4923 and 4946, are by Mr. R. Freeman, Mr. L. Ennis, Mr. J. F. Pain, Mr. G. Roberts and Dr. J. J. C. Bradfield, and the discussion will be held on April 10.

The bridge, which took a little more than eight years to complete, cost £4,248,000. It consists of a main span of 1,650 ft. with a clearance of 170 ft. over the central 300 ft. of span, and ten approach spans. It accommodates a roadway 57 ft. wide, four railway tracks and two footways. The principal parts of the main-span truss are of silicon steel with a modulus of elasticity of 30,500,000 lb. per sq. in. Analytical methods of calculation were used, arithmetical processes being carried out by calculating machines. Calculations were required for the following combinations of loads : dead load, live load and impact, horizontal force, centrifugal force, wind loads and temperature variation. Of the total weight of the main truss material, the proportions attributable to various loads are as follows : dead weight of arch, 35 per cent ; dead weight of deck, 23 per cent ; live load and impact, 26 per cent ; wind, 8 per cent ; horizontal force, 2 per cent ; and temperature, 6 per cent. Tests on model members were made by means of a testing machine of 1,250 tons capacity, capable of dealing with tension and compression specimens up to 50 ft. long and bend test specimens 20 ft. long. Tests of the arch after completion indicated a span $\frac{3}{4}$ in. in excess of 1,650 ft., a difference partly due to unavoidable errors of survey and possibly partly caused by shrinkage of the concrete below the bearings. The bridge was erected by Messrs. Dorman, Long and Co., of Middlesborough.

The *Indian Antiquary*

With the December issue, which, through labour troubles, has only just become available in Great Britain, the *Indian Antiquary* ceases publication. The demise of this valuable periodical will be greatly regretted by all who are interested in Indian studies. For more than sixty years it has served as a medium of publication for original communications of the highest standard of scholarship, dealing with the ethnology, archæology, history, linguistics, folk-lore and religions of India. The *Indian Antiquary* was founded by the late Dr. J. Burgess in 1872 and later was acquired by the late Sir Richard Temple as his sole property. Under his editorship—he was editor-in-chief for forty-six out of the fifty-one years of his connexion with it—the services of the *Indian Antiquary* to the cultural history of India were incalculable. Sir Richard Temple's wide knowledge of oriental subjects made him an ideal editor of a journal of this type, not merely because of his own numerous contributions to its pages, but also for the stimulus and assistance he was able to give to the studies of others. As one result of his influence may be mentioned *Epigraphia Indica*, the official record of epigraphic work in India, which was a direct outgrowth of work initiated by the *Indian Antiquary*. In 1924 Sir Richard Temple transferred his interest in the journal to a small private company, and the Royal Anthropological Institute assumed responsibility for its publication. Sir Richard Temple retained the editorship, at first in association with Mr. S. M. Edwardes, and after his death in 1927 with Mr. C. E. A. W. Oldham, who became editor-in-chief on Sir Richard's death in 1931. Owing to financial conditions the Royal Anthropological Institute felt compelled to sever its connexion with the *Indian Antiquary* in 1932 and during the past year it has been carried on by the editor in order to complete publication of matter in hand.

Protection of Power-Transmission Plant from Lightning

A series of articles on lightning by J. F. Shipley which is being reprinted in *Distribution of Electricity*, a paper published by W. T. Henley's Telegraph Works Co., gives a résumé of what has been accomplished in recent years in protecting transmission lines and engineering plant connected with them from damage from lightning. The effect of a lightning flash on a transmission line is to puncture the insulators or make them flash over, sometimes causing a short circuit which shuts down the supply. During the last forty years a very large number of devices have been employed to protect the lines, such as air-gaps, water-jets, oxide films, etc. These have been found only partially effective. The ideal arrester would be some link between the line and earth which would have infinite resistance at the normal pressure, but when for any reason that pressure increased by 10 or 20 per cent, the resistance should become practically zero, thus furnishing the impulsive rush of electricity with a safe path to earth. A recent device consists of a solid block of a material consisting of conducting particles of metallic oxide diffused in a baked clay which is microscopically porous. It is similar to porcelain in texture and mechanical strength and normally has almost infinite resistance. As soon as the electrical pressure across a block of it rises above a definite value its resistance decreases at a very rapid rate. If we double the voltage, the current it will pass increases more than twelve times. The material seems to have two names, 'thyrite' and 'ocelit'. As it is an artificial product and can be accurately controlled, it looks as if a real step forward has been made in the design of these arresters, or 'safety-valves' as they are often called.

Electric Waxing of Floors

Helios, a German electrical trade journal printed in Leipzig, gives descriptions in three parallel columns in German, French and English respectively of the latest electrical devices. In the issue for November 19 an interesting description is given of tests on an electric floor-waxing device, with and without a suction apparatus for the simultaneous collection of dust. The tests were carried out in the laboratories of several universities as well as in commercial test rooms. When the suction device was used there was no appreciable change in the percentage of dust in the air caused by the whirling of the waxing apparatus. When no suction device was employed the percentage of dust in the air increased as much as seven to eight times the normal quantity. In this case the dust on the floor was whirled upwards by the waxing machine. With the suction device it is not necessary to clean the room so often and there is no need to have a special vacuum cleaner. The dust which settles on furniture prolongs the work of cleaning, and certain works of art are damaged, while it is

also a menace to health. In many workshops the dust impairs the quality of the finished goods. The floor-waxing machine with suction device should prove specially useful in hotels, hospitals and sanatoriums.

Industrial Physics

THE address which Dr. Paul D. Foote delivered before the American Physical Society as retiring president appears in full in the February issue of the *Review of Scientific Instruments*. In it he points out how inadequately industrial physics has been represented on the Council of the Society, and how as a consequence much of the work of the members of the Society has failed to attract the attention of industrial executives and they are unable to see that there are places for physicists in their organisations. It has been left to large corporations like the General Electric Company to show how much physicists can do for industry. Dr. Foote considers that the training in physics in most of the American universities fits a man neither for industry nor for a position in a junior college, and that industry has to look to the engineering rather than to the physics departments for men adequately trained in the fundamentals of classical physics in preference to those superficially acquainted with the latest developments of quantum mechanics. He hopes that the newly-formed American Institute of Physics and the new journal *Physics* will secure more intimate contact between physics and industry, and that the attitude of the Society towards applied physics in the next few years will insure that physics becomes a real profession rather than an academic avocation. Since the foundation of the Institute of Physics, in London in 1918, the position of British physicists has improved. Lord Rutherford recently pointed out that there has been a rapidly growing recognition of the importance of the physicist, not only in the academic world but also in industry, and he considers that the Institute of Physics can justly claim some of the credit for this.

Tests for Accident Proneness

UNDER the title "Tests for Accident Proneness", the Industrial Health Research Board has published the results of a further investigation into the factors involved in "accident proneness" which have engaged its attention for several years (Medical Research Council: Industrial Health Research Board. Report No. 68: Tests for Accident Proneness. Pp. iv+37. London: H.M. Stationery Office, 1933. 9*d*. net). Previous work had established that certain individuals are inherently more liable to sustain industrial accidents than others exposed to the same risk. By the investigations of E. Farmer, E. G. Chambers and F. J. Kirk now reported, it has been established from experiments with groups of dockyard apprentices and naval artificers that, within the groups studied, poor æsthetokinetic co-ordination (defined as the ability to do certain sensori-motor tests) is associated with a liability to sustain an undue number of accidents. The results do not suggest that æsthetokinetic co-ordination is associated with accident proneness in all occupations, although it is probably associated with it in groups doing similar work to those tested. Deficiency in this function, however, only accounted for a part of the accidents sustained, and it is evident that only one of the factors involved in accident proneness has thus far been isolated and evaluated. Even this, however, makes a definite step towards the practical goal of detecting beforehand those specially liable to accident and warning them against entering dangerous occupations. No significant relation was observed between intelligence and accidents in any of the groups, and in two of them accident proneness did not decrease with age and experience. It does not follow, however, that in groups employed on different work, variations in intelligence may not play a part in accident proneness.

Scientific Survey of South-Eastern Polynesia

THE Bernice P. Bishop Museum, Honolulu, has organised an expedition, to be known as the Mangareva Expedition, for the study of the little-known parts of south-eastern Polynesia. Because other means of transportation are unavailable, the Expedition is provided with two ships. The *Islander* (Capt. W. G. Anderson), a high-powered sampan, was to leave Honolulu on March 1 and during a six months' cruise will serve as a 'master ship' for scientific workers who will conduct investigations chiefly at Mangareva, Oeno, Pitcairn, Rapa, Tubuai, Rurutu, Raivavae, and Rimitara islands. The second ship, the cutter yacht *Tiare Tahiti* (Capt. Robert S. Burrell), under charter from May until October, will serve primarily as a 'transfer ship' for the ethnologists at work in Mangareva and among the three hundred and sixty islands of the Tuamotu Archipelago. The chief purpose of the Expedition is to record the data regarding native races, flora and land fauna, which are disappearing at a surprisingly rapid rate. Incidental observations on geology, marine zoology and general oceanography will also be made. The scientific staff includes Dr. Peter H. Buck, Kenneth P. Emory and J. Frank Stimson, ethnologists; Prof. Harold St. John and Raymond Fosberg, botanists; Dr. C. Montague Cooke, Jr., and Donald Anderson, malacologists; and E. C. Zimmerman, field entomologist. Dr. C. Montague Cooke, Jr., has been appointed leader of the Expedition.

A History of Vegetables

THE *Gardeners' Chronicle* of March 3 publishes a report of a lecture on "The Introduction of Vegetables" by Mr. E. A. Bunyard. It comes as somewhat of a surprise to find that many of our common vegetables were once regarded as harmful plants, or were the subjects of religious prohibition. The broad bean, for example, was forbidden to the Egyptian priests, though later it was the cause of 'bean-feasts' to a bean god. Garlic, cabbage, asparagus and spinach have all had a somewhat chequered history. The scarlet runner bean was long prevented from becoming a table delicacy by its value for ornamental purposes. Tomatoes were first suspected of being poisonous, then became medicinal, and it was not until the 'eighties of last century that their nutritive

value was realised in Great Britain. The potato survived a great volume of scorn, and was finally introduced to cultivation through sheer necessity—it mitigated the hardships of several famines. Mr. Bunyard suggests, somewhat whimsically, that lilies and tulips are edible, and appeals for an extension of "the Elizabethan spirit of adventure in the vegetable garden".

Sir Henry Wellcome, F.R.S.

The President of the French Republic has paid a notable tribute to English medical and chemical research by conferring the honour of La Croix de Chevalier de la Légion d'Honneur upon Sir Henry Wellcome, who has also just been awarded the Remington medal of the American Pharmaceutical Association for distinguished service to pharmacy. Sir Henry is founder of the Wellcome Research Institution and head of Burroughs Wellcome and Co., London, manufacturers of fine chemicals and galenicals, with establishments in the United States, Italy, Canada, Australia, India, China, South Africa, the Argentine and other countries. Apart from the research and experimental laboratories of the establishments of Burroughs Wellcome and Co. which have carried out many original researches in pharmacy, Sir Henry Wellcome has established a number of scientific research laboratories and research museums which are co-ordinated under separate and distinct direction, such as the Wellcome Research Institution with its magnificent new building in Euston Road, London. In these associated chemical and medical research laboratories and museums, much original work has been done to throw light on abstruse problems in medicine and pharmacy and to settle hitherto uncertain points in the history of pharmacy.

Royal Irish Academy

At the stated meeting on March 16 of the Royal Irish Academy, the following members were elected: Prof. K. G. Emeléus, professor of physics, Queen's University of Belfast; Prof. T. T. Flynn, professor of zoology, Queen's University of Belfast; Dr. R. H. Hunter, senior lecturer in anatomy, Queen's University of Belfast; Rev. J. Hynes, professor of archæology, University College, Galway; Rev. G. V. Jourdan, professor of ecclesiastical history, University of Dublin; Prof. M. F. Liddell, professor of German, University of Dublin; Mr. C. Blake Whelan, archæologist. The Abbé Victor Grégoire has been elected an honorary member in the Department of Science and Prof. Ellis H. Minns, Prof. Michael Rostovtzeff and Prof. Jean B. Vendryes honorary members in the Department of Polite Literature and Antiquities.

Announcements

The first Royal Society soirée this year will be held in the Society's rooms at Burlington House on May 9 and the second on June 20.

Prof. A. M. Carr-Saunders, Charles Booth professor of social science, University of Liverpool, has been elected a member of the Athenæum under the provisions of Rule II of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts or for public service.

Prof. H. Levy, professor of mathematics at the Imperial College of Science, will deliver the twenty-fifth Conway Memorial Lecture on Wednesday, April 25, at 7 p.m. at Conway Hall, Red Lion Square, W.C.1, his subject being "Science in an Irrational Society". Admission will be free.

The Academy of Sciences of the U.S.S.R. has elected the following to honorary membership of the Society: Sir Frederick Gowland Hopkins, Cambridge; Prof. G. H. Hardy, Cambridge; Dr. E. Schrödinger, Berlin (now Oxford); Prof. David Hilbert, Göttingen; Prof. Max Born, Göttingen (now Cambridge); Prof. T. Levi-Civita, Rome; and Prof. Carl Størmer, Oslo. Prof. Vainio Tanner, Helsingfors, has been elected a corresponding member.

The Hillebrand Prize of the Chemical Society of Washington for the year 1933 has been awarded to the late Dr. Edward Wight Washburn for the discovery of the first practical method of separating the isotopes of hydrogen. He discovered the electrolytic method of separation, which has made possible the subsequent research into the properties of the isotopes of hydrogen, and has thus initiated almost a new era in chemistry, consequent upon the differences in the chemical and physical properties of these isotopes and their compounds.

The Council of the Iron and Steel Institute announces that His Majesty the King has been graciously pleased to accept the Bessemer Gold Medal of the Institute for 1934. His Majesty has been the patron of the Iron and Steel Institute since his accession. The Bessemer Gold Medal was founded in 1873 by the late Sir (then Mr.) Henry Bessemer, the discoverer of the Bessemer process of steel-making and the second president of the Iron and Steel Institute. It has been awarded annually since that date to distinguished benefactors of the industry and particularly for pre-eminent contributions towards the scientific and technical knowledge of iron and steel. In 1899 Queen Victoria, and in 1906 King Edward VII, agreed to be recipients of this Medal.

Applications are invited for the following appointments, on or before the dates mentioned:—A general manager for the Pigs Marketing Board—The Secretary, Pigs Marketing Board, Thames House, Millbank, London, S.W.1 (April 9). A public analyst for the Dorset County Council—The Clerk of the County Council, County Offices, Dorchester (April 18). A teacher of mathematics, and a teacher of applied mechanics and machine drawing, at the Junior Technical School, Sheffield—The Chief Education Officer, Leopold Street, Sheffield (April 19). A senior assistant librarian at University College, Hull—The Registrar (April 20). A temporary resident lecturer (woman) in history and geography at the Hereford Training College—The Principal.

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Behaviour of Condensed Helium near Absolute Zero

THE recently published measurements[1] on some properties of condensed helium, in conjunction with the facts known from the work of Keesom and his co-workers[2], allow us to draw some conclusions on the behaviour of helium at very low temperatures.

It has already been shown by Keesom, who found the melting pressure to become nearly independent of temperature, that the entropy difference between the two phases tends towards zero with falling temperature (Nernst's theorem)[3]. This means that the liquid phase has to go into an ordered state[4]. This change takes place at the λ-point and is associated with a large loss of energy which, though continuous, occurs in a relatively small temperature range. (One cannot say yet in which way this ordered state—called once by the author "liquid degeneration"—is realised. Keesom[5], who recently published very similar considerations, calls it a "quasi-crystalline" state ; Clusius[6] also speaks of a "crystalline" state and adds the more specialised assumption of an association starting in the λ-region.)

Since the entropy difference vanishes, the heat of fusion ($\varrho = T\Delta S = \Delta U + p\Delta V$) must tend towards zero *a fortiori*[7]. This can be realised in two possible ways : (1) both ΔU and $p\Delta V$ may become zero, and this could scarcely be interpreted in any other way than that both phases become identical. (The same would happen if the temperature coefficient of the melting pressure were not to disappear completely.) (2) ΔU and $p\Delta V$ become equal but of opposite sign, that is, (*a*) ΔU or (*b*) ΔV changes its sign. Our measurements now enable us to find both components of ϱ and to extrapolate their values to absolute zero. Although such an extrapolation entails some uncertainty, we think it accurate enough to draw the following conclusions.

One finds that along the melting curve the volume of the liquid remains always higher than that of the solid ; the volume difference even increases appreciably with falling temperature. The energy of the liquid at 4° is greater than that of the solid, just as with the normal liquid. At about 2·5°, however, the energy difference begins to fall rapidly, passes zero a little below 2° and approaches finally a value of about − 2 cal./gm.-atom. This would mean that the possibility 2 (*a*) is realised.

Thus the energy of the liquid at very low temperatures is smaller than that of the solid, contrary to the normal. Compressing the liquid to the solid, one has to do work against the repulsive forces, this work being greater than that done by the attractive forces. Now arises the question of the origin of these strong repulsive forces ; for at the interatomic distances realised in liquid helium there can be no appreciable repulsion originating in the atomic fields, every atom in the liquid having at its disposal a cube of 3·6 A. length, compared with the gas kinetic diameter of about 1·9 A.

In order to understand this we have to consider the part played by the zero point energy. Extrapolation of the measured latent heats of evaporation[8] to absolute zero gives an energy difference between the liquid without external pressure and the gas of about 14 cal. From our data it then follows that the corresponding values for the liquid and the solid under the equilibrium pressure are 13 cal. and 11 cal. respectively. Now the zero point energy of the solid under equilibrium pressure has a value of about 60 cal., so that the 'lattice energy' originating in the interatomic forces would amount to about 70 cal. Thus we see that the zero point energy compensates by far the greater part of the 'lattice energy' and therefore it must be the chief factor in the behaviour of the substance. Having made a first estimate of the magnitude of the zero point energy from the deviations from Trouton's rule, we have previously emphasised[9] that its large value probably is the explanation for helium remaining liquid. The attractive forces cannot diminish the volume until they are compensated by the atomic repulsive forces ; the helium cannot crystallise with the normal volume, but has to take up a bigger volume with corresponding smaller zero point energy[10]. Only high external pressure can compress it into the close-packed crystalline state.

With diminishing volume, the zero point energy must increase. So on compressing, one has to do work in order to increase the zero point energy, and this is equivalent in many respects to the existence of a repulsive force. At the interatomic distances realised in the liquid, this greatly exceeds the repulsive forces resulting from the atomic fields, and the most important factor in the compressibility is due to this.

Before going into further details, especially for explaining the negative coefficient of expansion below the λ-point, it seems necessary to have more specialised ideas on the structure of the liquid and to make assumptions for the way in which it passes into the ordered state. It may be possible that the expansion coefficient will become normal again at lower temperatures and that the negative value in the λ-region is of merely local character. For this reason we will await the result of investigations at very low temperatures, which are now in progress, before going into further discussion.

F. SIMON.

Clarendon Laboratory,
Oxford.
March 1.

[1] R. Kaischew and F. Simon, NATURE, **133**, 460, March 24, 1934.
[2] *Leid. Comm.*, No. 184*b*, 190*b*, 216*b*, 219*e*, 221*e*, *Physica*, **1**, 128, 161 ; 1934.
[3] *Leid. Comm.*, Suppl. 61*b*.
[4] F. Simon, *Z. Phys.*, **41**, 808 ; 1927. *Erg. ex. Naturw.*, **9**, 235, 247ff ; 1930. *Z. anorg. Chem.*, 203, 222 ; 1931.
[5] *Leid. Comm.*, Suppl., 71*e*.
[6] Paper read in Breslau, 1933, unpublished.
[7] See also the measurements at higher temperatures made with Steckel, *Z. phys. Chem.*, Bodensteinband, 737 ; 1931.
[8] L. I. Dana and H. Kamerlingh Onnes, *Leid. Comm.*, 179*c*.
[9] K. Bennewitz and F. Simon, *Z. Phys.*, **16**, 183 ; 1923.
[10] Compare also K. Wohl, *Z. phys. Chem.*, B, **2**, 104 ; 1929.

Wave Mechanics and Structural Chemistry

THE modern applications of wave mechanics to molecular structure, and in particular the method of molecular orbitals developed by Mulliken and Lennard-Jones, have shown that it is not expedient to treat the individual links between atoms separately, and that the electrons in the molecule must be treated as a whole. The organic chemist, on the other hand, regards the molecule as held together by links from

atom to atom, and the only distinction in kind which he recognises among links is into single, double and triple; and his method of representation is found to be capable of providing different formulæ for every experimentally distinct chemical substance; indeed it sometimes provides two formulæ for one substance, as with inseparable tautomers.

If these views are both true, it follows that if a molecule with one structural formula can have (in the sense of the molecular orbital theory) more than one electronic constitution, these must be able to change into one another in less time than is required to isolate the substance, which involves a half life period of not more than a second or so, and a correspondingly minute heat of activation.

Now on the theory of reaction proposed by London and Villars, and developed in detail by Eyring and Polanyi, the heat of activation of a chemical reaction is mainly the work needed to bring the atoms to those distances from one another which are required for their re-grouping into the products of the reaction. If this is so, an isomeric (tautomeric) reaction in which the atoms have nearly the same relative positions after as before, would have a very small heat of activation and would occur with great rapidity. This seems to provide a reconciliation between the conclusions of wave mechanics and those of structural chemistry. The atoms of a molecule may have one or more dispositions in space. The number of these is the number of isomeric formulæ provided by the structural theory. Only this number of forms can be isolated, because it is only between them that the rate of interconversion is slow. Any finer modifications of the electron distribution which wave mechanics can detect must involve nearly the same positions of the atoms in space, and hence cannot lead to new isomers, as these would change into one another too rapidly. We already know instances in which two structural formulæ give practically the same atomic positions, as in the Kekulé benzene formula, and then it is always found that the expected isomers are identical.

It should be possible to define more precisely what is meant by 'nearly' the same positions. We have evidence that the difference in length between a single and a double link, or in angle between the 109·5° of $X-X\diagdown_{X}$ and the 125° of $X=X\diagdown_{X}$ can be regarded as negligible from this point of view. But we must expect a considerable range of differences corresponding to the wide range in rates of conversion, from those tautomers which can be separated at low temperatures to those which change into one another at a rate too great to be observed by any known method.

N. V. Sidgwick.

Lincoln College, Oxford.
March 14.

Activities of Life and the Second Law of Thermodynamics

In a recent letter in Nature[1] Sir James Jeans, in replying to a criticism made by one of us[2], writes: "Given perfectly level and frictionless railways, a man may move millions of tons of matter, and thereby decrease the entropy of the world enormously, without incurring any corresponding increase of entropy through the combustion of food or fuel". Not only can this surprising statement be disproved, but the very reverse of it can be readily demonstrated. The entropy decrease associated with the sorting out of trucks depends not on the number of tons but on the number of trucks. Its magnitude would be the same if the trucks were replaced by an equal number of miniature trucks or counters or molecules. If a man were to sort out a million trucks, the entropy decrease would be of the same order of magnitude (to within a few powers of ten) as the increase of entropy when he breathes a million molecules of oxygen. To complete the proof of our assertion it is only necessary to estimate roughly how long it would take a man to sort out a million trucks and then estimate how many millions of millions of millions of millions of molecules of oxygen he must have breathed while he was doing it.

The same letter contains the statement: "We cannot, for example, suppose that the man who steers the *Mauretania* consumes food energy at a rate comparable with 100,000 h.p. more than normal". Indeed, no one with a knowledge of thermodynamics would suppose so. The entropy associated with the steering of the *Mauretania* is of the order of magnitude of Boltzmann's constant k, simply because there is only one *Mauretania* being steered. In thermodynamic parlance, the difference between the total energy and the free energy associated with the motion of the centre of mass of the *Mauretania* is of the order of magnitude kT, where T is the absolute temperature, and this quantity is some 10^{30} times smaller than the kinetic energy of the ship. The same thing may be expressed by saying that the Brownian movement of the *Mauretania* is negligible in comparison with its directed motion.

In view of Sir James's lapse in thermodynamic reasoning, we consider it not unreasonable to challenge his vague reference to "orthodox physiology", and ask on what experimental evidence he relies for his statement concerning entropy changes in the brain.

F. G. Donnan.
E. A. Guggenheim.

University College, London, and
University of Reading.
March 15.

[1] Nature, **133**, 174, Feb. 3, 1934.
[2] Nature, **133**, 99, Jan. 20, 1934.

Induced Radioactivity of the Lighter Elements

We have been investigating the phenomenon of induced radioactivity in aluminium, boron and magnesium recently reported by Curie and Joliot[1], and have been able fully to confirm their observations, and also to add further details. Using radium C′ α-particles reduced in range to 6·1 cm., we find the relative yields of positrons during the entire decay from aluminium, boron and magnesium to be approximately 30, 10 and 7. Since the periods are respectively 3¼, 14 and 2¼ minutes, the initial effects are in the ratio 6, 0·5, 2. With all materials we find an effect with a period of about 1 minute and of initial activity comparable with that of boron. This must be due to some impurity which is always present, such as carbon, nitrogen or oxygen.

Taking into account the solid angles involved, it appears that the probability of a 7×10^{6} volt α-particle producing a radiophosphorus atom by impact on aluminium is about 1 in 5×10^{6}. The above relative values are of no great significance, since the

yield varies rapidly with the energy of the α-particle in a manner dependent on the shape of the potential barrier, which of course is different in these three elements. This variation has been measured in the case of aluminium, and we find that the yield of positrons increases by a factor of 15 as the energy of the α-particle is changed from 5·5 to 7×10^6 volts.

Using thorium C′ α-particles, the measurements have been extended to $8{\cdot}3 \times 10^6$ volts, and the probability of excitation appears to be reaching a maximum here. This is in agreement with the far more detailed results obtained by investigating the protons liberated from aluminium by α-particles. Our results are compatible with the view that an α-particle colliding with an aluminium nucleus has a certain chance of being captured, and that from this arises a phenomenon analogous to radioactive branching, the two alternatives being presumably the immediate emission of either a proton or a neutron. It is the latter emission which produces the radioactive isotope of phosphorus, which emits positrons. The branching ratio appears to be of the order of 50 to 1 in favour of the proton emission.

While we have been able to detect the positrons from aluminium by magnetic focusing, the numbers were not sufficient to give definite measurements of the distribution with velocity, but we detected positrons over the range 1 million to at least 2½ million volts. Measurements of the absorption in copper and aluminium showed as the most significant feature an initial flat portion of the curve. Comparing these curves with those obtained with the same apparatus but using β-particles of thorium (C+C″) leads us to think that there are very few, if any, positrons of low energy. Practically all of the positrons are stopped by 1·2 gm./cm.² of aluminium, which in the case of β-particles would correspond to an energy of about 2½ million volts.

An interesting feature of these absorption curves is that radiation is detectable through several millimetres of lead. Part of this γ-radiation is presumably the radiation arising from the annihilation of the positrons.

A full report of these experiments will be published shortly.

C. D. ELLIS.
W. J. HENDERSON.

Cavendish Laboratory,
Cambridge.
March 26.

[1] NATURE, 133, 201, Feb. 10, 1934.

Inner Conversion in X-Ray Spectra

IN a recent communication[1], Saha and Mukerjie have pointed out that although the transition $L_{II,III} \rightarrow L_I$ is not forbidden by quantum mechanics, the X-ray spectral line corresponding to it has never been observed, and they have suggested that the failure to obtain such a line can be ascribed to its complete internal conversion in the M-shell. Such an explanation would appear, however, to be inconsistent with the conclusions reached by Taylor and Mott[2] in their recent discussion of the nature of the internal conversion process for γ-rays. (Clearly the same considerations will apply to the internal conversion of X-rays.) Briefly, stated in terms of the present problem, the conclusion reached is as follows: the presence of the M-electrons increases the number of $L_{III} \rightarrow L_I$ transitions above that to be expected from a direct calculation of the electric moment corresponding to such a transition, the rate of production of such 'induced transitions' being only slightly less than the rate of ejection of the M-electrons, and thus the intensity of the observed X-ray line should be only slightly decreased by the internal conversion.

It is evident, then, that the phenomenon of the internal conversion of X-rays (Auger effect) can have little bearing on the departure of measured X-ray line intensities from those calculated theoretically, and the statement that any radiation is "completely converted" in an inner shell is meaningless.

That the above considerations are in fact important in these problems has become evident from a theoretical investigation one of us (E. H. S. B.) is making of the Auger effect, full details of which will be published in due course. While not yet complete, this investigation is sufficiently advanced to show that, allowing for the presence of induced transitions, the K-series internal conversion coefficient (defined as the ratio of the number of Auger electrons to the total number of transitions to the K-shell occurring per unit time), is given closely by the expression $(1 + bZ^4)^{-1}$, Z being the atomic number of the element considered, and b a constant characteristic of the particular transition. A relation of this type satisfactorily fits the experimental data (as collected by Martin[3]) on the variation of the internal conversion coefficient with atomic number. If, however, there were no induced transitions, the internal conversion coefficient would be proportional to Z^{-4}, and there would then arise, for elements of low atomic number, the paradox that the number of Auger electrons emitted per unit time exceeds the total number of transitions.

H. M. TAYLOR.
E. H. S. BURHOP.

Cavendish Laboratory,
Cambridge.
March 14.

[1] NATURE, 133, 377, March 10, 1934.
[2] Taylor and Mott, *Proc. Roy. Soc.*, A, 142, 215; 1933.
[3] Martin, *Proc. Roy. Soc.*, A, 115, 420; 1927.

Nuclear Moments of the Antimony Isotopes

Badami[1] first reported the existence of complex fine structures in the visible lines of the Sb II spectrum. As a source he used a relatively high current arc (3–5 amp.), and to explain the structures he suggested that the nuclear spin of the isotope 121 is 5/2 and that of the 123 isotope is 7/2. (These are the only isotopes in antimony.)

I have succeeded in producing a very brilliant Sb II spectrum in a hollow cathode using only one-seventh of an ampere, and as a result the lines are so very much sharper than those in the arc, that the extremely complex patterns encountered are more completely resolved, many lines showing more components than those reported by Badami. The analysis of the line patterns shows without any doubt that the nuclear mechanical spins of both 121 and 123 are 5/2 but that the two isotopes have different nuclear magnetic moments in the ratio 1·36 : 1, the 121 isotope having the larger value. This may be compared with the ratio 1·27 : 1 in gallium, the only other known case which has two isotopes with identical spins (½) and different nuclear magnetic moments.

The following comparison of the structure given by Badami and by me for the line λ 5639·7 ($6s\ ^3P_2 - 6p\ ^3S_1$) shows to what extent the hollow cathode patterns are more clearly resolved:

Badami	0 (6)		205 (5)			450 (4)	584 (4)	760 (1)	cm.$^{-1}$ × 10^{-3}
Tolansky	0 (10)	71 (8)	217 (9)	319 (3)	399 (3½)	477 (6)	605 (5)	728 (1½)	cm.$^{-1}$ × 10^{-3}

It is seen that Badami's values are those which would arise from the blending of components due to excessive line width.

Full details with analysis will be communicated elsewhere shortly.

S. Tolansky.

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London, S.W.7.
March 3.

[1] J. S. Badami, *Z. Phys.*, **79**, 206; 1932.

The "Neutrino"

The view has recently been put forward[1] that a neutral particle of about electronic mass, and spin ½ħ (where ħ = $h/2\pi$) exists, and that this 'neutrino' is emitted together with an electron in β-decay. This assumption allows the conservation laws for energy and angular momentum to hold in nuclear physics[2]. Both the emitted electron and neutrino could be described either (*a*) as having existed before in the nucleus or (*b*) as being created at the time of emission. In a recent paper[3] Fermi has proposed a model of β-disintegration using (*b*) which seems to be confirmed by experiment.

According to (*a*), one should picture the neutron as being built up of a proton, an electron and a neutrino, while if one accepts (*b*), the rôles of neutron and proton would be symmetrical[4] and one would expect that positive electrons could also sometimes be created together with a neutrino in nuclear transformations. Therefore the experiments of Curie and Joliot[5] on an artificial positive β-decay give strong support to method (*b*), as one can scarcely assume the existence of positive electrons in the nucleus.

Why, then, have positive electrons never been found in the natural β-decay? This can be explained by the fact that radioactivity usually starts with α-emission and therefore leads to nuclei the charge of which is too small compared with their weight. The artificial β-emission was found for two unstable nuclei (most probably N^{13} and P^{30}) formed by capture of an α-particle and emission of a neutron, and therefore having too high a charge for their mass.

A consequence of assumption (*b*) is that two isobares differing by 1 in atomic number can only be stable if the difference of their masses is less than the mass of electron and neutrino together. For otherwise the heavier of the two elements would disintegrate with emission of a neutrino and either a positive or negative electron. There will be only a limited region on the mass defect curve, probably at medium atomic weight, where such small differences are possible. In fact, neighbouring isobares have only been found with the mass numbers 87, 115, 121, 123, (187), (203), while isobares with atomic numbers differing by 2 are very frequent. In the first case, one of the two nuclei (Rb) is known to emit β-rays. In each of the last two cases one of the two isobares is stated to be exceedingly rare and its identification might be due to experimental error. The other three cases actually lie close together and have medium weight. A particular case of isobares are proton and neutron. Since all experimentally deduced values of the neutron mass lie between 1·0068 and 1·0078, they are certainly both stable even if the mass of the neutrino should be zero.

The possibility of creating neutrinos necessarily implies the existence of annihilation processes. The most interesting amongst them would be the following: a neutrino hits a nucleus and a positive or negative electron is created while the neutrino disappears and the charge of the nucleus changes by 1.

The cross section σ for such processes for a neutrino of given energy may be estimated from the lifetime t of β-radiating nuclei giving neutrinos of the same energy. (This estimate is in accord with Fermi's model but is more general.) Dimensionally, the connexion will be

$$\sigma = A/t$$

where A has the dimension cm.^{2} sec. The longest length and time which can possibly be involved are $\hbar/mc$ and $\hbar/mc^2$. Therefore

$$\sigma < \frac{\hbar^3}{m^3c^4t}$$

For an energy of $2{\cdot}3 \times 10^6$ volts, t is 3 minutes and therefore $\sigma < 10^{-44}$ cm.^{2} (corresponding to a penetrating power of 10^{16} km. in solid matter). It is therefore absolutely impossible to observe processes of this kind with the neutrinos created in nuclear transformations.

With increasing energy, σ increases (in Fermi's model[3] for large energies as $(E/mc^2)^2$) but even if one assumes a very steep increase, it seems highly improbable that, even for cosmic ray energies, σ becomes large enough to allow the process to be observed.

If, therefore, the neutrino has no interaction with other particles besides the processes of creation and annihilation mentioned—and it is not necessary to assume interaction in order to explain the function of the neutrino in nuclear transformations—one can conclude that there is no practically possible way of observing the neutrino.

H. Bethe.
R. Peierls.

Physical Laboratory,
University,
Manchester.
Feb. 20.

[1] W. Pauli, quoted repeatedly since 1931, to be published shortly in "Rapports du Septième Conseil Solvay, Brussels", 1933.
[2] C. D. Ellis and N. F. Mott, *Proc. Roy. Soc.*, A, **141**, 502; 1933.
[3] E. Fermi, *La Ricerca Scientifica*, **2**, No. 12; 1933.
[4] This point of view was first put forward by I. Curie and F. Joliot at the Conseil Solvay, 1933.
[5] I. Curie and F. Joliot, Nature, **133**, 201, Feb. 10, 1934.

Changes in the Lipolytic Activity of Different Organs during Tuberculosis

In continuation of our earlier work on lipases[1], we have followed the changes in the lipase content of different organs of guinea pigs infected with bovine tuberculosis. Lipase determinations were made from liver, pancreas, lungs and blood serum, using tributyrine as substrate. It appeared that, coincident

with the development of tuberculosis, the lipolytic activity of liver, pancreas and of blood serum is considerably lowered. The results are given in the following table.

Lipase Content (Titrated Lipase Units) per 1 gm. of Fresh Material

	Liver	Pancreas	Lungs	Serum
Infected guinea pigs,	396 (117–566)	425 (191–733)	85 (48–130)	28 (22–36)
Controls,	1140 (898–1410)	832 (488–1391)	85 (46–107)	40 (34–46)

Each group consisted of five animals. The infected animals were killed 2–10 days before the expected natural death. The figures in brackets indicate the variations in respective series.

In certain series, when the bacterial strain used did not produce general tuberculosis, the lipase contents of liver and pancreas were not lowered, a decrease being noted only in blood serum.

The cause of the decrease of lipolytic activity of different organs during tuberculosis is still problematic. It might be assumed that the destructive action of the tubercle bacilli on the tissues also destroys the lipases. This assumption is supported by our observation that in the sound portions of liver the lipase content is considerably higher than in the portions infected by tuberculosis.

ARTTURI I. VIRTANEN.
PAAVO SUOMALAINEN.

Biochemical Institute,
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Feb. 14.

[1] *Acta Chemica Fennica*, B, **5**, 28; 1932. *Z. physiol. Chem.*, **219**, 1; 1933.

The Third Vitamin D

A SHORT time ago[1] we reported that vitamin D found in ether extract of meadow hay had the same properties as described by Kon and Booth[2] for vitamin D in butter, in that only one fifth of this vitamin after saponification is again found in the unsaponifiable fraction. We have since examined butter and have been able to confirm Kon and Booth's results as regards its vitamin D content. We considered it of interest to investigate whether the missing four fifths of the anti-rachitic vitamin might possibly be found in the saponifiable fraction of the ether extract of butter or hay. For this purpose, a small excess of acetic acid was added and the free fatty acids taken up with ether and isolated. It was then found that the missing four fifths of the original vitamin D were among the free fatty acids. Thus with alkali it gives a water-soluble substance; deprived of alkali, it is again soluble in ether.

As certain difficulties were involved in giving daily doses of natural butter, we tried to concentrate vitamin D in butter by shaking with a similar quantity of warm ethyl alcohol the melted butter fat which had been dried with sodium sulphate[3,4]. It proved that four per cent of the butter fat dissolved in the alcohol. This four per cent had an anti-rachitic strength 15 times as great as natural butter, inasmuch as it was active in curative daily doses of 20 mgm., as shown by Poulsson and Løvenskiold's method[5]. The product which was obtained was twice saponified and yielded 11·09 per cent unsaponifiable matter. Of this unsaponifiable matter it was necessary to give daily doses equivalent to 100 mgm. of the original extract in order to obtain an anti-rachitic result corresponding to 20 mgm. of this. Of the isolated free fatty acids, 25 mgm. per day produced the same effect as 20 mgm. of the initial material. Thus, it will be seen that about a fifth of the anti-rachitic vitamin has accompanied the unsaponifiable matter and about four fifths the saponifiable fraction. We obtained a similar result with ether extract of meadow hay. Here the daily doses of the hay powder extract were 4 mgm. Of the unsaponifiable matter they corresponded to 20 mgm. and of the fatty acids to 5 mgm.

It was of interest to investigate whether the vitamin D from cow's liver behaved similarly. Ether extract of cow's liver showed a suitable anti-rachitic effect in daily doses of 40 mgm. The unsaponifiable matter showed a corresponding effect in daily doses equivalent to 200 mgm. and the free fatty acids had a similar effect in daily doses of 60 mgm. In other words, vitamin D in extract of hay, cow's liver and butter has the same properties. With ether extract of the human liver, two thirds of the vitamin D is in the unsaponifiable matter and only one third among the free fatty acids. These conditions vary somewhat in the human being in the individual cases, a circumstance which is probably accounted for by the fact that the human being obtains sustenance from the products of both land and sea, and thus has a stock of the various D vitamins.

OTTAR RYGH.

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Skøyen, Oslo.
March 6.

[1] NATURE, **133**, 255, Feb. 17, 1934. In this letter an error appeared. At the end of the second paragraph, for 0·25 units read 10 units.
[2] Kon, S. K., and Booth, R. G., *Biochem. J.*, **27**, 1302; 1933.
[3] Shipley, Kinney, McCollum, *J. Biol. Chem.*, **59**, 177; 1927.
[4] Zucker, *Amer. J. Publ. Health*, **23**, 10; 1933.
[5] Poulsson, E., and Løvenskiold, H., *Bioch. J.*, **22**, No. 1; 1928.

Effect of a Meteoric Shower on the Ionosphere

OF the various agencies responsible for producing and maintaining ionisation of the ionosphere, bombardment of the upper atmosphere by meteors has been suggested as one. Skellett[1] has carried out a calculation of the energy received by the earth due to impact of the meteors and finds that during a meteoric shower it might be so high as a fourteenth of that due to ultra-violet light from the sun. He therefore concludes that meteoric showers might be one of the factors disturbing the ionisation of the upper atmosphere. In order to find if any correlation exists between the occurrence of the two phenomena, Schafer and Goodall[2] measured the height of the *E*-region during the Leonid meteoric shower of 1931. They found that on some nights the ionic density attained high values. Unfortunately, their observations were vitiated by a magnetic storm which was in progress at that time. Though they were unable to draw any definite conclusion regarding the correlation, they summarise their observations by saying that there is reason to believe that the presence of meteors in unusual numbers can cause increased ionisation of an intermittent nature in the region of the lower layer.

Considering the importance of the subject, we thought it worth while to take records of the ionisation content of the *E*-layer during the Leonid shower of 1933. The method employed was the well-known one developed by Appleton[3] and consisted in determining the frequency at which upwardly directed radio waves pierced the region under investi-

gation. Fig. 1 depicts the results of our observations carried out on the nights of November 13, 14 and 17, 1933, between the hours 2300 and 0700. It will be noticed that on the nights of November 13 and 14 the equivalent electron densities attained values of $3 \cdot 3 \times 10^5$ and $2 \cdot 2 \times 10^5$ respectively. The penetration frequencies for these ionic densities correspond to wave-lengths of 87 and 71·4 metres.

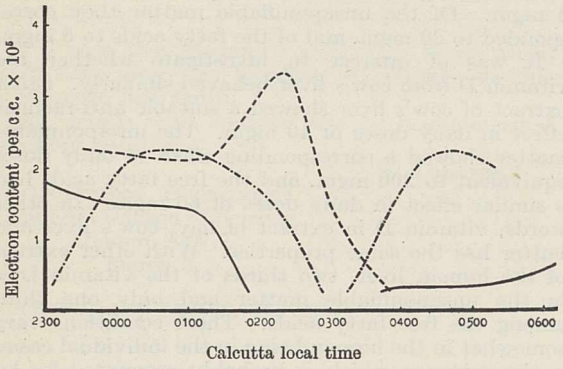

Fig. 1. Electron content of the *E*-layer during the 1933 Leonid shower.
– – –, Nov. 13; – · – ·, Nov. 14; ———, Nov. 17.

Such high densities are remarkable, because in the course of our fortnightly observations during the Polar Year 1932–33, we never recorded such densities. In fact we were never able to obtain echoes on 75 metres for our midnight observations. The high ionic density recorded, therefore, strongly suggests that the effect was due to the impact of meteors on the upper atmosphere. It should be mentioned that records kept at the Magnetic Observatory, Colaba, Bombay, and the Solar Observatory, Kodaikanal, Madras, show that no marked magnetic disturbance or solar activities occurred on these days.

S. K. Mitra.
P. Syam.
B. N. Ghose.

Wireless Laboratory,
University College of Science,
92, Upper Circular Road,
Calcutta.
Jan. 30.

[1] A. M. Skellett, *Proc. Inst. Radio Eng.*, **20**, 1933; 1932.
[2] J. P. Schafer and W. M. Goodall, *Proc. Inst. Radio Eng.*, **20**, 1941; 1932.
[3] E. V. Appleton, Nature, **127**, 197, Feb. 7, 1931.

Terminal and Initial Parenchyma in Wood

Mr. K. A. Chowdhury's remarks upon the position of the parenchyma in *Terminalia tomentosa*[1] would seem to be applicable to other woods also. A recent examination of the wood of *Cedrela odorata* in this laboratory showed that the larger vessels of the early wood are partly embedded in parenchyma, some of which, judged by its position, was laid down rather earlier than these vessels. It is possible that the latest wood of a season's growth consists chiefly of parenchyma, and that the early wood of the following season is similarly constituted; but the parenchyma is sufficiently homogeneous to render this possibility improbable. Another specimen of *Cedrela*, probably *C. odorata*, showed that the parenchyma separated a region of rather small, fairly thick-walled fibres from another of larger, relatively thin-walled fibres; the comparatively large size and thin walls of the cells of the parenchyma in both these specimens suggest that it was laid down at the beginning of a season's growth, not at the end; it is desirable to confirm this by studies on the living tree.

Several other Meliaceous woods were examined, but with less conclusive results. In *Swietenia Mahagoni*, the parenchyma appears to be terminal and not initial, and in this wood the parenchyma cells are rather small, with relatively thick walls, which would seem to confirm the view that they are laid down at the end of the growing season. In *Khaya grandis* and *Carapa guianensis*, it was not possible to decide if the parenchyma was terminal or initial.

It is well known that the vessels of the pore ring in teak (*Tectona grandis*) may be associated with parenchyma, and it would seem to be justifiable to refer to this as initial parenchyma.

Frank W. Jane.

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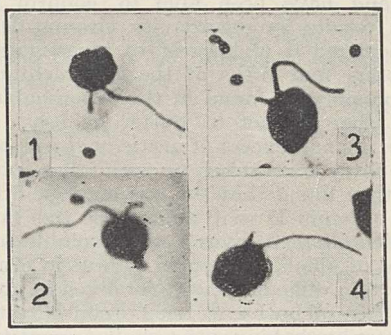
London.
Feb. 18.

[1] Nature, **133**, 215, Feb. 10, 1934.

Zoospore Ciliation in the Plasmodiophorales

Zoospores of *Plasmodiophora brassicæ*, Woron. and *Spongospora subterranea*, (Wallroth) Lagerheim have been described in the literature as uniciliate. Examination of active zoospores would appear to substantiate this description. However, when preparations stained by Cotner's[1] method are used, it can be shown that in addition to the long cilium, so apparent in the living zoospore, there is another which is shorter and less conspicuous. This biciliate character is illustrated by photomicrographs of zoospores of *P. brassicæ* (Figs. 1 and 2) and *S. subterranea* (Figs. 3 and 4).



Great numbers of such zoospores were obtained by germinating, in dilute inorganic nutrient solutions, resting spores which had previously been wet, frozen and dried several times. In size and manner of swimming, these zoospores fit the descriptions given by other writers.

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[1] *Bot. Gaz.*, **89**, 295; 1930.

Research Items

Lower Palæolithic 'Cleavers', Northern Nigeria. Mr. Henry Balfour in *Man* for February comments on the occurrence of the so-called cleaver of lower palæolithic facies in Nigeria. The implement is of axe-like type, characterised mainly by having the cutting edge formed by the intersection of two large flake-scars, one on either side of the surface of the implement. The junction of the two scars along the lower margin affords a very sharp cutting edge which, however, does not stand prolonged hard usage. Until recent years, this type has received scant recognition, since it had been noted as an occasional occurrence only among Chelleo-Acheulean implements and was considered to be somewhat rare. In South Africa it must be accorded the status of a dominant type in view of its abundance and wide distribution south of the Zambezi. Its further dispersal in Africa is a matter of importance and its occurrence in northern Nigeria, where it had not previously been recorded, is to be noted. Well-defined examples are included in a collection of implements of lower palæolithic facies which is housed in the Government Offices at Jos on the Bauchi Plateau. These were discovered largely in the course of tin-mining operations. Two examples, of which sketches were made by the author, are figured. Of these one is about 16 cm. long by 8·7 cm. in maximum width and consists of a massive flake. The greater area of one surface is the untouched scar of detachment; the other surface exhibits a large area of coarse flaking. The second is larger and better worked, possibly of diorite, 17·5 cm. long by nearly 11 cm. wide. It is considerably weathered and patinated. The form is more symmetrical and the flaking less coarse than in the first specimen, but the technique is similar in the two instances. There can be no doubt that the cleavers of West and South Africa are closely related morphologically.

Tuamotuan Religion. The religious beliefs of the natives of Tuamotu archipelago, which extends for more than 600 miles from north-west to south-east between the Society Islands and the Marquesas, are studied by Mr. J. Frank Stimson in *Bulletins* 103 and 111 of the Bernice P. Bishop Museum, Honolulu. Few natives are now acquainted with the pre-Christian beliefs; but the difficulties of study are further increased by the fact that there would appear to have been two forms of belief, an esoteric belief, the cult of a supreme god Kiho, knowledge of which was confined to priests and nobles, and an exoteric cult for the ordinary people, in which the name of the supreme deity was concealed or disguised. This esoteric knowledge in the form of chants or cosmogonic descriptive and genealogical material was handed down from generation to generation, but owing to a confusion with the powers of evil in early missionary days it came to be looked upon as suspect, and has now almost vanished. The philosophic ideas of the chants, of which a series is recorded in *Bulletin* 111, were of an extremely high order. Study of the distribution of this cult, of which traces are to be found in various parts of Polynesia, suggests that it was introduced into the Pacific by an early wave of Polynesians, termed for convenience palæ-Polynesian, the ideas it embodied possibly being derived from an ancient civilisation in south-eastern Asia. These palæ-Polynesians carried the cult to Tahiti, and thence in successive migrations to the marginal confines of Polynesia. A later Polynesian wave, which may be designated neo-Polynesian, developed a religious system emphasising the creative rather than the 'tree' type of cosmogenesis, wherein Tangaroa was viewed as the supreme creator. The exoteric version of the cult posited a group of secondary gods, whose attributes were suited to the beliefs of the people and served them as objects of worship and as tutelary deities.

Land Snakes of Hong-Kong. Twenty-nine species of land snakes, belonging to twenty genera, have been recorded from Hong-Kong Territories, and a key to the genera and some species has been compiled by G. A. C. Herklots (*Hong Kong Naturalist*, 4, 113, Dec. 1933). Of the twenty-nine species, no fewer than six are venomous, and two of these are described and portrayed in colour—the common krait (*Bungarus multicinctus*) and the banded krait (*B. fasciatus*). The bite of the latter is fatal to fowls and dogs, but apparently not to man. On the other hand, the virulence of the common krait is about twice that of the cobra and twenty-eight times that of the banded krait; an account is repeated of the deaths of three men successively bitten by the Indian race of common krait, while a fourth recovered after being seriously ill.

Invertebrates from the Vanderbilt Museum. A fourth volume of the reports on the collections made by Mr. William K. Vanderbilt on a series of cruises conducted in his yachts *Eagle* and *Ara* has now been published, adding Cœlenterata, Echinodermata and Mollusca to those on fishes and Crustacea (*Bull. Vanderbilt Marine Museum*, vol. 4. "Scientific Results of Cruises of the Yachts *Eagle* and *Ara* 1921–1928, William K. Vanderbilt, Commanding. Cœlenterata, Echinodermata and Mollusca". By Lee Boone. Huntington, Long Island, N.Y.). Four faunal regions are involved in these expeditions, the West Indian region, the Labrador-New England region, the tropical American Pacific and the Mediterranean. The depths dredged varied from quite shallow water to 900 fathoms, besides littoral collections. Notes from colour sketches made by Mr. Vanderbilt on the spot are added. The specimens are chiefly known species but one new coral is described, *Corallum vanderbilti* from Cuba, dredged by the *Ara* below 100 fathoms. One colony of *Stenogorgia casta*, Verrill, hitherto only known from the type locality taken by the *Blake* was found off the Alligator Reef, Florida, and is many times larger than the type. There is a magnificent collection of echinoderms with many details of spines and pedicellariæ well figured, but perhaps the most interesting find was a mother octopus *Octopus vulgaris*, about 10 in. across the umbrella, guarding her young, the brood numbering 522, seven of which had not fully escaped from the egg capsule. This was taken from a loggerhead sponge, Knight's Key, Florida, dredging at 2 fathoms. A female octopus may lay up to 1,000 eggs in a brood, all connected by a thin flexible rope fastened in some rock crevice. The mother tends them, blowing water on them through her funnel, cleaning and aerating them. This is probably the first capture of an entire brood. An egg-laden

female *Argonauta argo* with about 500 eggs in the shell was dredged from 300 fathoms from off Cape Mala, Panama.

Larval Decapods from Madras. Mr. M. Krishna Menon describes some very interesting larvæ in his paper "The Life-Histories of Decapod Crustacea from Madras" (*Bull. Madras Gov. Mus.* New Series. Natural History Section, Vol. 3. No. 3. 1933). There are many decapod larvæ in the Madras plankton in the period immediately following the monsoons, the end of November and the four following months. Not only do we know little about the life-histories of the decapods from this particular region, but we also know little of those from almost any region, and any detailed investigation of this kind is valuable. The animals chosen are *Acetes erythraeus* in the family Sergestidæ, a *Callianassa* and (probably) a *Upogebia* species unknown, and *Hippa asiatica*. Unfortunately, it was not possible to hatch the eggs in the laboratory, but it was found that late larvæ could often be kept until they metamorphosed and the genus or species ascertained. A complete account of the development of *Acetes* is given for the first time, for the larvæ are very common in the Madras plankton, eight larval stages being described. Both the Callianassa and Upogebiid are interesting and present unusual features, the first having an abbreviated development showing certain affinities with *Axius*, the second having some unique features among the Upogebiinæ. The adult of this last larva has not been obtained.

Tropical Pacific Foraminifera. In his paper "The Foraminifera of the Tropical Pacific Collections of the *Albatross*, 1899–1900" (Part 2, Lagenidæ to Alveolinellidæ, United States National Museum. Bull. 161, 1933) J. A. Cushman continues to describe and illustrate the Foraminifera of the tropical Pacific collected by the United States Bureau of Fisheries steamer *Albatross* together with certain other related material from shallow water of the same region. From the study of the shallow-water Foraminifera living in the various oceanic islands, it has become evident that many species are very localised in their distribution, and probably a careful survey of the different island groups will show that there are many of these isolated species or varieties that have not yet been recognised. When these occur, they are often to be found in great numbers, as is frequently the case with such localised species in other groups. The genus *Lagena* is the largest of those recorded, with no less than 29 species and several varieties. The author states that there is scarcely any other group of Foraminifera in which so much is needed in the way of detailed studies in regard to structure and variation. Many of the species seem to be very widely distributed while others have very definite ranges. He includes *Entosolenia* with *Lagena* although fully realising the distinction between them, leaving the complete study of this important group for future workers. The paper is illustrated with 19 excellent photographic plates.

Australian *Casuarinas*. A short article in the *Argus* of Melbourne, Australia, dated March 4, 1933, gives a very interesting description of several commercially useful species of the genus *Casuarina* ("Australian Oaks; their Economic Value" by J. W. Audas). Australian species of *Casuarina* or 'sheoaks' are evergreen and grow rapidly, have long life, are free from diseases and pests, have wood which is of high quality for cabinet-making and is resistant to the effects of weather, and even the bark is of medicinal value. The trees will grow on the poorest of soils, and the young sprouts provide food for cattle. To this end they are often pollarded. Loose sandy soils may be stabilised by growing species of *Casuarina* upon them. The economic characteristics of *Casuarina suberosa* (black sheoak), *C. stricta* (drooping sheoak), *C. Luehmannii* (buloke) and *C. glauca* (grey buloke) are given, and a plea for their extended cultivation is made.

Genetics of Poppies. A genetical investigation of the poppies has been made by Dr. J. Philp (*J. Genetics*, **28**, No. 2). In *Papaver Rhœas*, which shows some self-sterility, the inheritance of eight factors for flower-colour has been investigated. For seven of these factors 91 of the 128 possible phenotypes have been recognised. These factors are found to fall into three linkage groups. There appear to be two factors for hair colour, one of which is linked with two of the factors for petal colour. Doubleness is incompletely recessive to singleness and is probably controlled by several factors. Latex colour is also apparently determined by two factors and is affected by the factor *p* for flower colour. The phenomena of segregation and crossing-over are the same for the male and female sides. The species is very heterozygous, while *P. commutatum*, which has a narrower distribution, is very homozygous, indicating that the natural selection of types has been more intense or that mutations have occurred less freely. This may perhaps explain the general dominance or epistasy of its characters over those of *P. rhœas*. The two species are regarded as recently differentiated from a common origin and both have $2n = 14$ chromosomes.

Crustal Blocks in the Kwanto District. In an earlier memoir (see Nature, **129**, 321; 1932), Prof. N. Miyabe showed that, in the Boso peninsula, the earth's crust consists of many blocks that have been tilted in various directions. He has now applied the same methods to the south-west Kwanto district (*Bull. Earthq. Res. Inst.*, 11, 639–692; 1933), using the vertical displacements of nearly 500 secondary and tertiary triangulation points during the interval 1892–1925. In this way, he has drawn the boundaries of 73 blocks, the horizontal dimensions of which are about 10 km., and has determined the magnitudes and directions of their tilts. Some of them may consist of several secondary blocks, each 2–3 km. across. Both the tilting and the vertical displacement of the blocks are, as a rule, greater to the west, than to the east, of the River Sagami. Near Ooiso, one block was elevated 127·6 cm., while closely adjoining blocks to the north-west were lowered by 67·9 and 77·5 cm. Several of the boundaries of the blocks agree fairly well with known tectonic lines. For example, the Tanna fault, along which displacements occurred with the earthquake of November 26, 1930, coincides nearly with the eastern boundary of a block in the Idu peninsula.

Population Map of England. A map showing the density of population of England and Wales at the census of 1931 has been published by the Ordnance Survey (1*s.* 6*d.*, flat and unmounted). This completes the map of Great Britain, of which the Scottish sheet was published last year. The scale is 1 to 1,000,000. Density of population is shown by

deepening tints of brown, olive, green and black, which merge as satisfactorily as tints can be expected to do. There are twelve tints ranging from "occasional" population of 0–1 per square mile to "very congested" of 76,800 or more per square mile. There are inset maps of the County of London (scale 4 miles to an inch) and county boundaries. Names on the main map are those of towns, certain physical features and, in blue, rivers and lakes. Index letters and numbers in the margin facilitate reference. The sheet overlaps the previously published one from northern Yorkshire to the Firth of Forth. A one sheet edition of the combined sheets is also published.

Rainfall in Netherlands Indies. Dr. J. Boerema has extended his statistical study of the rainfall of the Netherlands Indies (*Kon. Mag. Met. Observ. Batavia*, No. 26). This is the fourth volume dealing with this subject and consists entirely of rainfall maps for Celebes on a scale of one to three million. The maps give a picture of the average annual rainfall, and also the average rainfall for each individual month, by means of isohyets ; the zones of different intensities bounded by the various isohyets are brought into prominence by a scale of shading and the use of blue tint for the heavier falls. The interval between successive isohyets has to be large, as Celebes lies in the tropical rain belt (the equator passes through the northern part of the island) and it is only in October that the blue tint (rainfall more than 300 mm., that is, than about 12 in.) does not appear anywhere on the map. The interval on the annual map is 500 mm. except for the wettest regions where it changes to 1,000 mm., and on the monthly maps is 50 mm. for the dry regions and 100 mm. for the wet. The presentation of the rainfall in this form, although very good for most purposes, is not very suitable for a comparative study of the seasonal variation of rainfall in different parts of the island. They show, however, that the seasonal variation is far from following a similar course throughout the island.

Progressive Lightning. Schonland and Collens (*Proc. Roy. Soc.*, A, Feb.) have photographed a number of South African lightning flashes using a camera invented by Boys in which two lenses are mounted at opposite ends of a diameter of a circle and rotated at high speed about the centre of the circle. Successive parts of a discharge are thus drawn out along a circular track. By comparing the pictures produced by the two lenses moving in opposite directions, the nature of a flash may be elucidated. The measurements show that in many cases the first stroke of a flash consists of a bright dart moving from cloud to earth with a velocity of the order 8×10^8 cm. per sec. The bright dart is of the order 50 metres long, and probably consists of an avalanche of electrons. The evidence is that the flashes which show 'leader' strokes are such that the base of the cloud is the cathode of the discharge and that a dart of electrons can be propagated at the velocities observed. The strokes which follow the leader spread from the ground upwards, with higher velocities of the order 10^{10} cm. per sec. These strokes resemble flames rather than darts and it is suggested that the ionisation is thermal in character. In some cases these main strokes branched upwards, the branches developing after the main discharge had developed at the branching point (see also NATURE, **132**, 407, Sept. 9, 1933).

Photochemical Union of Hydrogen and Chlorine. Bateman and Allmand (*J. Chem. Soc.*, 157 ; 1933) describe some experiments on the effect of light of varying wave-length on the photochemical union of a mixture of pure hydrogen and chlorine, which did not exhibit any induction period when confined over water. Insolation was effected by either a quartz mercury lamp or a tungsten filament lamp in conjunction with a large aperture quartz monochromator. The results correct some previously reported (cf. NATURE, **131**, 656, May 6, 1933). It was found that the rate of photochemical union in monochromatic light of wave-length 313 mμ was proportional to the intensity and that the quantum yield was independent of wave-length between 400 and 490 mμ. The quantum yield remained of the same order also from 400 mμ to 290 mμ but appeared to fall off by 10–20 per cent when passing from the visible to the ultra-violet region. It also fell off when passing from 490 mμ to longer wave-lengths. It had previously been shown that the reaction was definitely sensitive to light of 546 mμ (the green mercury line), and in the present experiments a definite reaction was found in the region 540–550 mμ. With monochromatic mercury lamp radiation of 492 mμ, anomalous results were found. This wave-length lies just beyond the convergence limit, 478·5 mμ, of the chlorine banded spectrum. The relative quantum efficiencies were found to be low at first but progressively increased from values below 1 to a constant value of 8. Interposition of dark periods during the increasing range caused a fall on re-illumination, but had no effect when the value 8 had been attained. No anomaly in this region was found with the continuous light source.

Heavy Water. The *Journal of the American Chemical Society* of February contains several communications on heavy water and heavy hydrogen. Gilfillan examined the density of water obtained by distillation of sea water, both that taken from a depth and that from the surface. In both cases an excess of density above the normal was found. Different samples of sea water gave the same specific gravity whilst tap water purified in the same way gave a different value, the specific gravity of the distillate from sea water being 1·0000023 at 0° when water from tap water is taken as unity. Halford, Anderson and Bates find that transfer of heavy hydrogen from water to acetone occurs on warming the two liquids together in presence of potassium carbonate. Davis and Johnston find a separation of hydrogen isotopes when water is treated with sodium. G. N. Lewis and Schutz describe the properties of acetic acid containing the heavy isotope of hydrogen. This acid melted 3·3° below ordinary acetic acid and shows a higher vapour pressure, because of the higher association in the vapour phase. The heavy isotope was in the carboxyl hydrogen and no interchange with the hydrogen in the methyl group occurs on treatment. Lewis, Macdonald and Schutz have prepared hydrochloric acid with the heavy isotope and measured the vapour pressures of the liquid and solid forms. The results give $\log_{10} p_1/p_2 = 15{\cdot}4/T - 0{\cdot}075$ for the liquids and $\log_{10} p_1/p_2 = -57{\cdot}7/T + 0{\cdot}387$ for the solids. The ratio of the vapour pressures reaches a maximum of 1·05 at the triple point, below which they approach each other as the temperature is lowered. The calculated heat of fusion is very low.

Outlying Museums of the Empire*

THE great survey of the museums of the Empire, conceived by Sir Henry Miers and S. F. Markham, has now been completed by them with the assistance of Dr. F. A. Bather, T. Sheppard and others. The final reports, on the museums in scattered outliers of the British Empire, bring to a close a series of surveys which has reviewed more than a thousand museums and art galleries. For the accomplishment and success of these surveys, as well as to the surveyors, credit must be awarded to the Carnegie Corporation of New York which financed the inquiries, and to the Museums Association which acted as general headquarters and under the name of which the reports have been published. Along with the reports proper (bound in paper covers), there are issued (bound in cloth, as if for much service) a directory of the museums in Australia and New Zealand and another of those in the scattered islands of the Empire, compilations the merit of which makes it certain that from this starting-point the progress of these museums will be measured.

The condition of the isolated and island museums is the most unsatisfactory revealed by the Empire Survey. "The reason may be possibly historic, possibly psychological, but whatever the cause all observers agree that the islands of the British Empire present one of the most difficult problems in the realm of cultural services." Yet from the reports it is clear, and one's own knowledge of their publications confirms, that in places excellent scientific work has been done, as in the Raffles Museum at Singapore or the Sarawak Museum at Kuching. But in most places valuable scientific material is disappearing with little attempt at collection and conservation, simply because finances are inadequate. Exhibited collections suffer from the same inadequacies of money and staff, though the fact that in several of the places illiterate natives form (as in Colombo) an overwhelming proportion of the museum visitors, must tend to discourage the utmost effort at arrangement, since neither English nor vernacular labels are understood. Yet these natives get pleasure and interest from the exhibits themselves.

Many of the remarks in the report on Australia and New Zealand apply to both countries, and indeed to other Dominions. Both have been severely hit by the depression and the staffs of their museums have not kept pace with their growth or have been actually reduced, with the inevitable deterioration. Over and over again it is insisted that the chief need of a museum is a competent and keen curator, who deserves an adequate salary. We read of one of the oldest and most important museums being run by a director and a taxidermist and of university-trained botanists and entomologists receiving less than £3 a week. Buildings are often inadequate and liable to destruction by fire. In these circumstances the good work already accomplished, generally by private or municipal effort (more marked in New Zealand than in Australia), is to be warmly commended.

Writing for the Carnegie Corporation, the authors naturally emphasise the exhibition and educational side of museum work and occasionally seem merely to tolerate the researches made known by the museums in many excellent publications. No doubt they themselves actually realise that in a new country being changed by civilisation the first duty of a museum is conservation and that research must precede exposition. Governing authorities, however, are slow to realise the help that museums might give to education, to general culture, and to the severely practical work of life.

The advantages of co-operation are insisted on, and here the Museums Association can extend its good work. Recently it has brought into being a strong Empire Committee, on which representatives of the Home Government and of the Dominions meet those who have conducted the surveys, in order to administer to best advantage the funds allotted by the Carnegie Corporation. But loans, exchanges, and the pooling of information are no less important. The Dominions desire much from the Homeland, but is it not ridiculous that type-specimens of British Jurassic plants and shells should, as the Directory tells us, be in an Antipodean museum ?

* Reports on the Museums of Ceylon, British Malaya, the West Indies, etc. Pp. 58. Directory of Museums in Ceylon, British Malaya, Hong Kong, Sarawak, British North Borneo, Fiji, the West Indies, British Guiana. Pp. 67. (London: Museums Association, 1933–1934.) Reports, with Directory, 5*s*. A Report on the Museums and Art Galleries of Australia, by S. F. Markham and Prof. H. C. Richards, to the Carnegie Corporation of New York; and A Report on the Museums and Art Galleries of New Zealand, by S. F. Markham and W. R. B. Oliver, to the Carnegie Corporation of New York. Pp. v+113+13 plates. Directory of Museums and Art Galleries in Australia and New Zealand. Compiled by S. F. Markham and Dr. H. C. Richards. Pp. 115. (London: Museums Association, 1933–1934.)

The Roll-call of the Hydrogens (Hydranes)

By Prof. Henry E. Armstrong, F.R.S.

1. THE task of naming the homologues of hydrogen is not to be undertaken lightly. Nomenclature is of such importance that all considerations should be laid aside, except those of reasoned expediency and sound philological practice. The example set by Faraday, just a century ago, in framing names for use in describing and discussing electrochemical phenomena, may well serve us to-day. His words have stood the test of time, because of the extreme care with which they were chosen.

2. The new gases (from water) are clearly all *Hydrogens* (Water-stuffs), as each has its own water in water. They are to be grouped under their *Atomic Number* 1, as homologous members of the first term in the periodic series of elements. It would seem to be desirable to have an index name common to all members of the group. *Deuterium* is in no way reminiscent of water and also has no particular group significance. 'Second to what ?' is the question that at once arises. The name would be a fit one for the first member of the second group (*Atomic Number* 2) in the periodic series. If we could agree so to use it, succeeding groups might well have similarly significant group names—*Triterium*, *Tetraterium*, etc., up to 92, in addition to the familiar names.

3. Members of the first group are logically all to be regarded and represented as *Hydrogens*, in the same way that members of the C_nH_{2n+2} series of saturated hydrocarbons are all included under the group name

Paraffins or Methanes (*Ethanes*). The individual names of these all have the same ending and are also significant of composition, as a series of numerical indices are prefixed to a single terminal. The principle thus followed in naming homologous paraffins may well be followed in naming hydrogens. One of the happiest suggestions ever made was Hofmann's, that the terminal *ane* should be applied to all paraffins. In the chemist's mind, *ane* is now always associated with an initial series. Hofmann took the second great step in systematic nomenclature, the first being that taken by Lavoisier and his colleagues. Methyl, ethyl and propyl being well-established, good names, he preserved these and began numbering at the fourth term, tetrane.

4. Applying the Hofmann principle to the hydrogens we have the names

Hydrogen, Deuthydrogen, Trithydrogen.

Maybe it will be found that the series ends here and that further addition of a proton gives rise to a complex which swallows its own tail, producing helium. Helium may not be like a whale but it is very like the closed complex benzene. Earthly chemists may be forgiven if they go so far as to imagine that not a few elements may come to be regarded as polyhelides, just as a large proportion of hydrocarbons are polybenzenes. It is permissible to be prophetic even at a christening party. Lord Rutherford would seem to forecast the possibility of a *prohelium*, in the second group, of weight 3—an elemental trimethylene.

5. Hydrogen, however, is not a name that is universally used. At least an alias, of a more general character, may be desirable. In all humility, I suggest the simple term *hydrane*. The analogy with methane will be obvious :—

	Alternative symbols		
Hydrane	H	H^{α}	H
Deuthydrane	HH	H^{β}	H^2
Trithydrane	HHH	H^{γ}	H^3

With reference to the special symbols here introduced, we represent paraffins by complex structural formulæ, by special symbols such as $CH_3.CH_3$, why not hydranes ? Recent observations (NATURE, Feb. 17) seem to indicate peculiarities in behaviour which justify, if they do not demand, the use of peculiar symbols.

6. Compounds might be named systematically as follows :

Hydranol (Hydrol) / Hydranone (Hydrone)	H.O.H
Deuthydrancne (deuthydrone)	HH.O.HH
Hemideuthydranone (hydrone)	H.O.HH
Hydranamine (hydramine)	NH_3
Deuthydranamine (deuthydramine)	$NH_2.HH$
Di ,, ,,	$NH.HH_2$
Tri ,, ,,	$N.HH_3$
Deuthydranomethane	$CH_3.HH$
Dideuthydranomethane	$CH_2.HH_2$
Tri ,, ,,	$CH.HH_3$
Tetra ,, ,,	$C.HH_4$

7. If proton be the name given to the elemental unit H, the corresponding deuthydrogen or deuthydrane unit would be properly named if it were termed the *deuthydranon* or *deuthydron*. I would go a step further, however, and ask if it be not expedient to pay homage to Prout, whose prophetic contention that the elements are all of unitarian build has now been placed beyond doubt by Aston's refined measurements ? Proton might well be changed into *prouton*. This would be of meaning to all who have knowledge of the history of our science.

8. The *neutron* creates a difficulty, as do all things not understood. We shall do well, perhaps, to await its better acquaintance, before attempting to place it by name. Subatomic chemistry seems to be entering upon a phase not unlike that to which we are accustomed in atomic, structural chemistry—as the evidence grows that distinct structural units, not protons alone, are concerned. The use of prefixes denoting energy differences may well prove to be desirable : *Cataprouton* might serve as an alias of neutron in this event. *Balliston* is another possibility, as it is a mere missile.

9. The argument applies equally to electrons, now that so-called positrons are claiming attention. Might not these be brought under the Faraday hat ? Are such terms possible as an-, ano- or anodoelectron and cath-, catho- or cathodoelectron ? At present, the *on* is a mere terminal, without special significance. An alternative would be to speak simply of l- and d-electrons, according to the twist given to them in the magnetic field.

10. One other task that we have long shirked may be considered here—the naming of elements in the alternative states of atom and molecule. Lavoisier drew a clear distinction between *oxygen*, the stuff in oxygen compounds, on one hand ; and *oxygen gas*, on the other. We now symbolise the difference by writing O and O_2. Hydrogen and oxygen are the stuffs in water—why not use the names only with this significance and term the gases *Dishydrogen* and *Disoxygen ?* We have no hesitation in speaking of dimethyl and diphenyl. Ozone then becomes trisoxygen. Maybe the now conventional *ion* terminal makes such change unnecessary, though this is only applicable to hydrogen in salts. The long familiar term *radicle* also still holds the field. Probably together these terms will suffice : in any case, too many *radical* changes are undesirable.

Rubber-Growing Research in the U.S.S.R.

A DETERMINED attempt to make Russia independent of imported rubber in a few years' time is being made by investigating the possibility of home-grown rubber, and by the manufacture of 'synthetic rubber' ; four factories are already engaged in the industrial production of the latter. Research on the growing of rubber is carried out at two rubber institutes working in conjunction with the Institute of Plant Industry. Expeditions have been sent out to search at home and abroad for suitable rubber-bearing plants, the indigenous flora having been particularly carefully surveyed.

The three most promising plants so far appear to be *Parthenium argentatum*, Gray, *Scorzonera tausaghis*, and *Taraxacum gymnanthum*, D.C. The first-named, the guayule, brought from Mexico, has been the subject of several investigations[1]. This plant has several varieties, differing in rubber content, resistance

to drought and cold, and also in the quantity and germination of seed produced; easy propagation by seed is important for the economical production of rubber from this type of plant.

Scorzonera tau-saghis grows wild in Central Asia, and was first described by the staff of the Institute in 1931. It is a slow-growing perennial, very readily reproducing itself vegetatively, and is rich in best quality rubber. *Taraxacum*, a biennial, occurs in the south of the Crimea. Loman, Kotov and Tcherkacov have described the last two[2]. These indigenous plants have not been under observation so long as the guayule, but are considered very promising owing to the high quality of their rubber and the ease of separating it. The two native plants are also noteworthy for a low proportion of resin to rubber, and the fact that the rubber contained in them is in the form of fine threads; this form of occurrence has not been encountered previously by the investigators.

Experimental plantations of the first two plants named above are in existence, many of them large enough to enable the trials to be carried out on a commercial scale. It has been planned to have more than 500,000 hectares under rubber cultivation by 1937.

[1] Nickolaev, Astrov and others, *Bull. App. Bot.*, **22**, 4; 1929; **2**, 3, 1932, etc.
[2] *Nature* [translation of the Russian title], **2**; 1933.

University and Educational Intelligence

Cambridge.—The governing body of King's College, having made provision for four additional fellowships open for competition to graduate members and research students of the University, offers for competition a fellowship in mathematics including theoretical physics to be associated with the names of the late Arthur Berry and Frank Ramsey. Further information can be obtained from the Provost, to whom applications should be made by November 1.

London.—The title of reader in aeronautics in the University has been conferred on Dr. N. A. V. Piercy, East London College.

Prof. Karl Pearson has been appointed Heath Clark lecturer for the year 1934.

Wales.—The Council of University College, Aberystwyth, has accepted with regret the resignation of Principal Sir Henry Stuart Jones on the grounds of ill-health. Prof. Gwilym Owen, professor of physics, has been appointed acting-principal of the College for the remainder of the current session.

A memorial tablet to the late Principal J. H. Davies has been unveiled in the College quadrangle

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Research in chemistry and physics will be heavily subsidised by the United States Federal Government if a bill lately introduced into the House of Representatives for the establishment of research fellowships should be passed into law. According to a Science Service report of January 19, the bill proposes that the Secretary of Commerce be given twenty million dollars for this purpose. Any citizen with a bachelor's degree who demonstrates, by examination, his suitability, would be put to work under a university professor. It is open to question whether the scheme is as sound as the Wisconsin plan (Nature, 132, 977, Dec. 23, 1933), for relieving professors temporarily of all teaching duties in order to enable them to devote themselves to research.

Science News a Century Ago

Royal Society

On April 10, 1834, Mr. J. W. Lubbock, treasurer, in the chair, nineteen further candidates were elected into the fellowship, contrasting with to-day's limit of seventeen allowed in a whole year. Their names were :—Viscount Adair, Charles Ansell, Felix Booth, Lieut. Alexander Burnes, Francis Corbaux, Sir William Folkes, James W. Freshfield, John Davies Gilbert, Edward Griffith, Edmund Halswell, Dr. William Henry, Robert Hudson, the Rev. William F. Lloyd, John Phillips, Capt. Walter N. Smee, William Spence, Henry S. Thornton, Dr. John Warburton, Horace H. Wilson.

Among the newly elected in the above list, some names suggest special reference. Felix Booth was a munificent patron of arctic and antarctic exploration. Lieut. (afterwards Sir) Alexander Burnes was a distinguished Indian officer who explored the Punjab, Afghanistan, and Bokhara, in 1830–33. Returning to England in 1833 he received a great welcome. In 1841 Burnes met with a tragic fate, being killed by Afghan insurgents. John Phillips, geologist, was a nephew of William Smith, the 'father of English geology'. In 1853 Phillips succeeded Strickland as deputy reader in geology at Oxford; three years later, on the death of Buckland, he was appointed to the professorship. William Spence, entomologist, collaborated in many publications with William Kirby, elected into the Society sixteen years earlier.

Death of John Fuller

On April 11, 1834, John Fuller of Rose Hill, Sussex, who founded the Fullerian professorships at the Royal Institution, died in Devonshire Place at the age of seventy-seven years. In 1777 he had succeeded to the estate of his uncle Rose Fuller, M.P. for Rye, and three years later was elected M.P. for Southampton, holding his seat until 1784. Made Sheriff for Sussex in 1797, in 1802 he was elected M.P. for the county after a contest lasting sixteen days and costing him £20,000 in addition to a purse of £30,000 subscribed by the county. He sat until 1812. On one occasion in 1810 Fuller made a scene in the House, was taken into custody and severely reprimanded by the Speaker. At Rose Hill he erected an observatory. He was buried on April 18, 1834, in the family vault at Brightling, Sussex.

James Bowman Lindsay

On April 11, 1834, the *Dundee Advertiser* published the following advertisement. "J. B. Lindsay resumes classes for cultivating the intellectual and historical portions of knowledge and instruction on April 14, 1834, in South Tay Street, Dundee. In a few weeks hence a course of lectures will be formed on frictional, galvanic, and voltaic electricity, magnetism, and electromagnetism. The battery, already powerful, is undergoing daily augmentation. The light obtained from it is intensely bright, and the number of lights may be increased without limit. A great number of wheels may be turned by electricity, and small weights raised over pulleys. Houses and towns will in a short time be lighted by electricity instead of gas, and heated by it instead of coal; and machinery will be worked by it instead of steam—all at a trifling expense. A miniature view of all these effects will be exhibited, besides a number of subordinate experiments, including the discoveries of Sir Humphry Davy." Lindsay was born in 1799 and died in 1862.

Self-Instruction in Chemistry

The popularity of chemistry a century ago is recalled by an article entitled "Practical Helps to a Cheap Course of Self-Instruction in Experimental Chemistry", contained in the *Mechanics Magazine* for April 12, 1834. "The extensive utility of chemical knowledge," the writer said, "has caused it to be very generally, nay, almost universally cultivated; but it is a branch of philosophy so entirely founded on experiment, that no person can understand it so as to verify its fundamental truths, unless he conducts experiments himself. . . . A notion that a laboratory, fitted up with furnaces and expensive and complicated apparatus, is absolutely necessary to perform chemical experiments is exceedingly erroneous; in fact diametrically opposite to the truth. For all ordinary chemical purposes and even for the prosecution of new and important inquiries very simple means are sufficient." The writer gave a list of pieces of apparatus and of the substances which should be obtained, the whole of which were considered to be in the reach of persons of even the most modest means, and intending experimenters were advised to purchase their chemicals from either Mr. Dymond, 146 Holborn-bars, or Mr. Davy, 390 Strand.

FitzRoy on the River Santa Cruz

On April 13, H.M.S. *Beagle* anchored in the mouth of the Santa Cruz, where she remained until May 12. On April 18, Capt. FitzRoy set out with three whaleboats to explore the river and was away until May 8. Darwin accompanied the expedition and his "Diary" contains an account of the work done. The party consisted of twenty-five souls, all well armed and capable of defying a host of Indians. "With a strong flood tide & a fine day," says Darwin, "we made a good run, soon drank some of the fresh water, & at night were nearly above the tidal influence. The river here assumed a size & appearance which even at the highest point we ultimately reached, was scarcely diminished. It is generally from three to four hundred yards broad, & in the centre about seventeen feet deep; and perhaps its most remarkable feature is the constant rapidity of the current, which in its whole course runs at the rate of from four to six knots an hour. . . . In so strong a current it was of course quite impossible either to pull or sail, so that the three boats were fastened astern of each other; two hands left in each, & the rest all on shore to track (we brought with us collars all ready fitted to a whale line). The tracking party was divided into two and *every one* pulled in alternate spells of one and a half hours."

On April 22, Darwin records, "The country remains the same, and terribly uninteresting. The great similarity in production is a striking feature in all Patagonia." On April 29, he says, "from the high land we hailed with joy the snowy summits of the Cordilleras, as they were seen occasionally peeping through their dusky envelope of clouds". On May 4, the party was about 140 miles from the Atlantic and 60 miles from the nearest inlet of the Pacific, and here they "took a farewell look at the Cordilleras which probably in this part had never been viewed by other European eyes, & then returned to the tents". By May 8, they were back at the mouth of the river where they found "the Beagle with her masts up, freshly painted, & as gay as a frigate".

Societies and Academies

LONDON

Mineralogical Society, January 25. JAMES PHEMISTER: Zoning in plagioclase feldspar. The paper describes various types of zoning in plagioclase feldspar in the calciferous sandstone basalt lavas in one district of Scotland. The zoning is classified as (*a*) normal, (*b*) simple reverse, (*c*) oscillatory. Simple reverse zoning is associated with other differences in the zones which point to important time intervals between the growth of the zones. Oscillatory zoning is classified as oscillatory-normal and oscillatory-reverse and attention is directed to the occurrence of oscillatory-zoned crystals which show no general tendency towards either more calcic or more sodic plagioclase. Distinction is drawn between the main zones and the thin shells of alternately more and less calcic composition within the main zones. The alternating composition of the thin shells is possibly the result of lack of balance between rate of growth of the crystal and rate of diffusion from the surrounding magma. Recurrence of calcic plagioclase in the inner part of main zones is explained as the result of eruption of hot magma into the crystallising liquid, probably consequent on eruption of lava at higher levels. H. H. READ: On zoned associations of antigorite, talc, actinolite, chlorite and biotite in Unst, Shetland Islands. In an injection-zone within the staurolite-kyanite-garnet-gneisses of western Unst occur spherical or ellipsoidal bodies, up to 20 ft. in diameter, composed of an interior of antigorite, followed outwards by an orderly sequence of zones made up entirely of talc, of actinolite, of chlorite, and of biotite. It is considered that the zoned bodies result from the fragmentation of peridotite sills during the staurolite-kyanite-garnet metamorphism, followed by the entry of fluids into the masses during injection-metamorphism and the formation of the zonally arranged layers. At the same time, material displaced from the masses reacted with the country-rock to give the biotite-zone. Transitions to the country-rock were mostly pared away during the later chloritoid- and chlorite-producing metamorphisms that have affected the staurolite-kyanite-garnet-gneisses. M. H. HEY and F. A. BANNISTER: Studies on the zeolites (7). Clinoptilolite, a silica-rich variety of heulandite. Rotation photographs of a single crystal from the original specimen of 'clinoptilolite' (so-called 'crystallized mordenite' of L. V. Pirsson) show that it is a silica-rich variety of heulandite. The chemical composition and optical properties are in agreement with this interpretation. The mineral bears no relation to ptilolite. B. RAMO RAO and A. BRAMMALL: Notes on cordierite in the Dartmoor granite. Two groups of associated, but as yet unrelated, facts were recorded concerning the sector-twinned cordierite in the garnetiferous granite of Sweltor: (1) an aggregate of cordierite grains is separable into fractions varying in composition; in particular, the molecular ratio FeO/MgO varies from 0·37 to 1·28 in six intermediate fractions analysed, the ratio for the aggregate being 1·52. (2) all sectors are optically negative, but the value of $2V$ varies between 56° and 72°. Centrally paired sectors give the same $2V$ value, whereas adjacent sectors often give different values, the maximum difference observed being 12°.

Physical Society, February 2. S. R. Rao and G. Sivaramakrishnan: A new method of determining the magnetic susceptibilities of gases and vapours. Compensation is effected for the test bulbs; and the influence of surface condensation, if any, of gases and vapours can be allowed for. Electromagnetic retorsion is employed, and the arrangement is rendered independent of small changes in the magnetising current. The molar susceptibility of carbon dioxide was found to be $-(20{\cdot}79 \pm 0{\cdot}08) \times 10^{-6}$. L. R. Wilberforce: Magnetised ellipsoids and shells in a permeable medium. The probability that the field round a thin normally magnetised shell is independent of the permeability of the medium surrounding it is discussed. W. D. Wright and F. H. G. Pitt: Hue-discrimination in normal colour-vision. Hue-discrimination curves have been obtained for five normal observers; the apparatus and method of observation are described and the results discussed. Two minima in the discrimination curve are found at about $0{\cdot}60\mu$ and $0{\cdot}49\mu$ and a secondary minimum at $0{\cdot}45\mu$. The curves are appreciably different from those normally reproduced in textbooks, particularly at the red end of the spectrum where a secondary minimum has generally been shown. N. R. Tawde: Intensity-distribution in molecular spectra: N_2, second positive system. Intensities of bands in the $c^3\pi \rightarrow b^3\pi$ system of N_2 under four different conditions of excitation have been measured by means of calibrated photographs of the spectrum; transition-probabilities derived from these have been compared with the Condon parabola as obtained from Morse's and Rydberg's potential energy functions; effective temperatures have been derived on the assumption of a Boltzmann distribution for vibrational energy.

Dublin

Royal Irish Academy, January 22. Joseph Algar and John P. Flynn: A new method for the synthesis of flavonols. Flavonols may be prepared, in small yield, by the oxidation of flavindogenides of the type 3-benzylidene-flavanone in alcoholic alkaline solution by means of hydrogen peroxide. Considerably better results are obtained by adding 30 per cent hydrogen peroxide to a solution of an *o*-hydroxyphenylstyryl ketone in hot alcoholic potash. The preparation, in this manner, of a number of flavonols is described. Since *o*-hydroxyphenylstyryl ketones are readily prepared, the reaction affords a convenient method for the synthesis of flavonols. The products are readily purified and in most cases satisfactory yields (20–40 per cent) are obtained.

Edinburgh

Royal Society, March 5. E. B. Bailey and W. J. McCallien: The metamorphic rocks of north-east Antrim. The schists of Antrim fall into the following Scottish groups: Ben Lui Schists, Loch Tay Limestone, Pitlochry Schists, Green Beds, Ben Ledi Schists. The Loch Tay Limestone outcrops at Torr Head and passes north-westward under the Ben Lui Schists. The local evidence does not definitely decide whether this is due to inversion or not. The main interest is the occurrence of green beds on two distinct structural levels, the lower at Leckpatrick and Loughaveema, the upper at Runabay Head and Cushendun Bay. This is probably caused by recumbent folding of a single horizon. Support is thus lent to Clough's interpretation of Cowal. Other features of the district are the prominence of albite-schists in the Pitlochry and Ben Ledi groups, and the frequent development of hornblende in the green beds. This last is largely attributed to alteration by the Cushendun granite. Robert Carrick: Spermatogenesis of axolotl (*Amblystoma tigrinum*). The haploid chromosome number in the male is fourteen, plus a small accessory chromosome which usually divides in the first maturation division. This division is the meiotic one, and is preceded by parasyndetic union of homologous chromosomes. Pairing is initiated at the proximal pole of the nucleus and the polarised homologues twist about each other from the very onset of syndesis, equivalent chromomeres along their length being brought together during the process. Amitotic division does not occur among primary spermatogonia. Details of spermogenesis are not discussed. P. Ch. Koller: Spermatogenesis in *Drosophila pseudo-obscura*, Frol. (2). The cytological basis of sterility in the hybrid males of races *A* and *B*. The chromosome behaviour of the sterile hybrid male during spermatogenesis is highly abnormal. The chromosomes remain univalent usually in the first meiotic division; aneuploid and sometimes polyploid spermatids are formed which degenerate. The chromosomes of races *A* and *B* are at least partially homologous, and they are associated in the hybrid female. Therefore it is suggested that the cause of anomalous chromosome behaviour is genetical. Complimentary genetic factors are responsible for the sterility of hybrid males. Thomas Nicol: Studies on the reproductive system in the guinea pig: observations on the ovaries with special reference to the corpus luteum. Data for forty female guinea pigs are analysed. If several corpora lutea are formed at the immediate post-partum ovulation and the animal becomes pregnant, all of these persist and become corpora lutea of pregnancy, whether or not all the ova were fertilised. Numbers of new and old corpora lutea seldom correspond in the same female. Prenatal mortality is 29·5 per cent and seems chiefly due to lack of fertilisation of the ova shed. No evidence for alternating action of ovaries, or that migration of ova occurs. In subsequent pregnancies the uterine horn used is a matter of chance.

Leeds

Philosophical and Literary Society, December 12. C. W. Gilham: The condition that a certain integral may be rational. The invariant condition that the integral $\int f dx/\varphi^3$ should be rational in value is obtained, f and φ being polynomials of degrees seven and three respectively. R. Whiddington and F. C. Poultney: Note on the photographic intensity measurement of moving electron beams. A very brief account of a method of comparing electron beam currents of widely different values by moving the beams across a photographic plate at known rates and comparing the resulting densities of the traces. R. Whiddington: Note on a new transition produced by electron impact in helium. This note refers to a letter in Nature of June 24, 1933, where it was pointed out *inter alia* that electrons of a few hundred volts energy produced, in addition to the well-known ($1^1S_0 - 2^1P_1$) transition of 21·1 volts, another line at about 42 volts corresponding to two successive collisions by the same electron and yet a third line at about 60 volts. Careful measurement of this last line shows it to correspond to a loss of 59·2 volts. It cannot therefore be due to the

process $3(1^1S_0 \rightarrow 2^1P_1) = 63{\cdot}3$ volts—a result not unexpected in view of the high probability of the transition as shown by the density of the line in the photographs. It is likely to be due to some multiple excitation in which the same impacting electron within the atom carries out more than one process—such, for example, as simultaneous excitation of the two atom electrons, or even possibly ionisation plus excitation. H. M. DAWSON and N. B. DYSON: The rate of hydrolysis of bromoacetic acid in relation to its degree of ionisation. The marked fall in the rate of hydrolysis of bromoacetic acid, which is observed when the hydrogen ion concentration is increased by the addition of a strong acid, cannot be attributed to the elimination of the reaction which depends on collisions between bromoacetate ions and water molecules. On the contrary, the fall is mainly due to the reduction in the velocity of the hydrolytic process, which is primarily due to collisions between bromoacetate ions and bromoacetic acid molecules. J. W. BELTON: The kinetic interpretation of the activity coefficients of non-electrolytes. The activity coefficient of a non-electrolyte in presence of an electrolyte is dependent on the adsorption potential at the solid-liquid interface. The expression derived is in qualitative agreement with experiment. C. H. DOUGLAS-CLARK: Spectroscopy and valency (2). The periodic groups of non-hydride diatomic molecules. The classification of non-hydride diatomic molecules into their appropriate periodic groups becomes possible according to various combinations of (1) two groups of non-bonding electrons (nine kinds), and (2) one group of shared electrons (twenty kinds). The groups resemble those of the Periodic Table, and are divided in a similar way into *A* and *B* sub-groups. The new table possesses the leading advantages of the older classification. Further discussion is to follow. C. H. DOUGLAS-CLARK: An interconversion scale for energetic and related magnitudes in the electromagnetic wave band. Interconversion of the magnitudes wave-length, wave-number, frequency, electron velocity, mass, temperature corresponding to maximum energy, energy in electron-volts, ergs, calories and kilogram-calories per gram-molecule, may be conveniently accomplished by means of a scale covering the electromagnetic wave-band over 90 octaves from $\lambda = 10^{20}$ to ($\approx$) 10^{-7} A. Advantages of the scale in spectroscopic and general work are noted, with special reference to losses of mass occurring on assembling atomic nuclei from their constituent parts, and to the temperature corresponding to energy of maximum density. L. LOOSE, W. H. PEARSALL and F. M. WILLIS: Carbon assimilation by *Chlorella* in Windermere. Measurements of oxygen production by *Chlorella vulgaris* at different depths in Windermere, show that carbon assimilation exceeds respiration on an average August day to a depth of ten metres, which also represents the depth of the epilimnion at that time. Cell division was apparently most rapid below this depth, but cell extension and cell mortality are highest nearest to the surface.

PARIS

Academy of Sciences, February 12 (*C.R.*, **198**, 625–684). V. GRIGNARD: The preparation of certain organomagnesium compounds by removal. In cases where the yield of the organomagnesium compound is small or nothing, the addition of a solvent, such as ethyl bromide, which appears to keep the surface of the magnesium clean, has been found to give good results. The method has been successfully applied to *p*-bromveratrol, *p*-dibrombenzene and similar difficult reactions. LOUIS ROY: The conditions of visibility and the separation of a satellite star. J. TOUCHARD: A problem of permutations. ALFRED ROSENBLATT: Non-linear *m*-harmonic equations with two independent variables. ANTOINE MAGNAN and CLAUDE MAGNAN: A chronophotograph with ultra-rapid recording. The apparatus described and illustrated is designed to give 30,000 images per second. MICHEL LUNTZ and PAUL SCHWARZ: Circular alternated eddies. GEORGES BRUEL: Map of the Moyen-Ogooué to the sea (1/500,000) of A. Meunier (1932). AL. PROCA: Particles that may be associated with the propagation of a light wave. LÉON and EUGÈNE BLOCH: A new spectrum of zinc, Zn IV. JEAN SAVERNIN: Polarisation by remote diffraction at the rectilinear edge of a steel screen. JEAN BOUCHARD: Influence of the solvent on the law of variation of the fluorescent power of certain colouring materials as a function of the concentration of their solutions. AUGUSTIN BOUTARIC and MARIUS PEYRAUD: The relation between the ascent of colloidal granules in porous bodies and their adsorption in the support in which the rise takes place. O. BINDER: Action of aqueous solutions of copper sulphate on cupric hydroxide. Both the method of Schreinemakers and X-ray analysis lead to the conclusion that the definite compound $4CuO.SO_3.4H_2O$ is the only substance produced by the interaction of aqueous solutions of copper sulphate and cupric hydroxide. DANIEL MOTARD: The alkaline bismuthoiodides. A. VILA: The rapid microdetermination of phosphorus in organic products. The ammonium phosphomolybdate precipitate is measured in a special form of tube after centrifugation. CH. PRÉVOST and LOSSON: The knowledge of the stycerols. MARIUS BADOCHE: The preparation of 1.1′.3′.triphenyl-3-carboxy-rubene, $C_{36}H_{23}.CO_2H$, and its alkaline salts. MARCEL GODCHOT and MLLE. GERMAINE CAUQUIL: The active *cis* and *trans* 1.methyl-3-cyclohexanols. HENRI CLÉMENT: The organomagnesium compound of pentamethylbenzene. This compound cannot be obtained by the usual method but on adding some ethyl bromide as suggested by Grignard, the reaction takes place normally, with good yields. S. GOLDSZTAUB: The crystalline structure of iron oxychloride. Results of a complete X-ray study. JACQUES DE LAPPARENT: The constitution and origin of leverrierite. C. ARAMBOURG: The eruptive formations of Turkana (Eastern Africa). MME. E. JÉRÉMINE: The volcanic rocks on the western edge of Lake Rodolphe. TONY BALLU: The condition of the soil and the effect of an agricultural tractor. CHARLES ROUSSEAU: The structure of the hepatic epithelium of the eolidians. MLLE. ANNE RAFFY: The influence of variations of salinity on the respiratory intensity of *Telphusa* and crayfish. C. LEVADITI, A. VAISMAN and MLLE. R. SCHŒN: The biological properties of the syphilitic virus contained in the residual syphilomes of treated animals. FERON and ANDRÉ LANCIEN: The association of the cinnamic radical and copper in the treatment of leprosy. After prolonged study (four thousand injections) the author concludes that the cuprocinnamic complex probably attacks the root of the disease. It is painless and can be injected even in very young subjects. If it does not always cure, there is scarcely a case in which it cannot bring about marked improvement.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, April 8

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30: Capt. Guy Dollman: "The Evolution of the Horse".*

Monday, April 9

VICTORIA INSTITUTE, at 4.30.—Mrs. A. S. D. Maunder: "Early Hindu Astronomy".

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Capt. M. Hotine: "The East African Arc of Meridian".

Friday, April 13

ROYAL SOCIETY OF ARTS, at 4.30.—J. H. Field: "Indian Meteorology".

INTERNATIONAL RADIO CONGRESS, April 10–15.—To be held at Warsaw.

FARADAY SOCIETY, April 12–14.—General discussion on "The Determination and Interpretation of Dipole Moments", to be held at Exeter College, Oxford.

GEOGRAPHICAL ASSOCIATION, April 13–14.—Spring Conference to be held at Glasgow.

Official Publications Received

GREAT BRITAIN AND IRELAND

Ministry of Agriculture and Fisheries. Collected Leaflets, No. 2: Insect Pests of Fruit Trees. Pp. iv+104. (London: H. M. Stationery Office.) 1*s.* 6*d.* net.

Memoirs of the Cotton Research Station, Trinidad. Series B: Physiology, No. 5: Further Studies on Transport in the Cotton Plant. 1: Preliminary Observations on the Transport of Phosphorus, Potassium and Calcium; 2: An Ontogenetic Study of Concentrations and Vertical Gradients. By T. G. Mason and E. J. Maskell. Pp. 125–173+119–141. (London: Empire Cotton Growing Corporation.) 2*s.* 6*d.*

Reports of the Progress of Applied Chemistry. Vol. 18, 1933. Pp. 770. (London: Society of Chemical Industry.) 12*s.* 6*d.*; to Members, 7*s.* 6*d.*

Subject Index to the Geological Literature added to the Geological Society's Library during the Years ended December 31st, 1923 and 1924. Pp. 144. (London: Geological Society.) 5*s.*

The Generic Names of British Insects. Prepared by the Committee on Generic Nomenclature of the Royal Entomological Society of London, with the Assistance of the Department of Entomology of the British Museum (Natural History). Part 2: The Generic Names of the British Rhopalocera, with a Check List of the Species. Pp. ii+9–40. (London: Royal Entomological Society.) 3*s.* 6*d.*

Department of Scientific and Industrial Research. Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-Water. Fourteenth (Interim) Report of the Committee of the Institution of Civil Engineers. Edited by John Purser and H. J. Grose. Pp. iv+56+19 plates. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

Observations made at the Royal Observatory, Greenwich, in the Year 1932, in Astronomy, Magnetism and Meteorology, under the direction of Sir Frank Dyson. Pp. vii+A62+B7+Cix+C59+D64+E46+18. (London: H.M. Stationery Office.) 27*s.* 6*d.* net.

Proceedings of the Royal Society of Edinburgh, Session 1933–1934. Vol. 54, Part 1, No. 3: The Cruciform Muscle of Lamellibranchs. By Alastair Graham. Pp. 17–30. 1*s.* 3*d.* Transactions of the Royal Society of Edinburgh. Vol. 57, Part 3, No. 32: Studies on the Scottish Marine Fauna; Quantitative Distribution of the Echinoderms and the Natural Faunistic Divisions of the North Sea. By A. C. Stephens. Pp. 777–787. 1*s.* 6*d.* Vol. 77, Part 3, No. 33: The Sequence of Floras in the Upper Carboniferous, with Special Reference to South Wales. By Dr. Emily Dix. Pp. 789–838. 7*s.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Proceedings of the Royal Society of Edinburgh, Session 1933–1934. Vol. 54, Part 1, No. 4: The Developmental Stages of *Euchaeta norvegica*, Boeck. By Dr. A. G. Nicholls. Pp. 31–50. 1*s.* 9*d.* Vol. 54, Part 1, No. 5: The Weight and Chemical Composition of *Euchaeta norvegica*, Boeck. By A. P. Orr. Pp. 51–55. 6*d.* Vol. 54, Part 1, No. 6: Studies on the Reproductive System in the Guinea-Pig; Observations on the Ovaries, with Special Reference to the Corpus Luteum. By Thomas Nicol. Pp. 56–66. 1*s.* Transactions of the Royal Society of Edinburgh. Vol. 57, Part 2, No. 18: A Study of the Foliar Endoderms in the Plantaginaceæ. By George Trapp. Pp. 523–546. 3*s.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Wool Industries Research Association. Report of the Council, 1933–34. Pp. 35. Scientific Research applied to the Wool Industries. Pp. 23. (Leeds.)

Education in Kent during the Five Years 1928–1933. Pp. iv+225+19 plates. (Maidstone: Kent Education Committee.)

OTHER COUNTRIES

Det Kongelige Departement for Handel, Sjøfart, Industri, Håndverk og Fiskeri: Norges Svalbard- og Ishavsundersøkelser: Skrifter om Svalbard og Ishavet. Nr. 57: Geology of the King's Bay Region, Spitsbergen, with Special Reference to the Coal Deposits. By Anders K. Orvin. Pp. ii+195+7 plates. 20.00 kr. Nr. 60: Late-Quaternary Oscillations of Level in South-east Greenland. By Thoralf Vogt. Pp. 44. 5.00 kr. Nr. 61: Zoological Results of the Norwegian Scientific Expeditions to East Greenland, 3: i. Report on the Sponges of the Norwegian Expeditions to East Greenland (1930, 1931 and 1932), by Maurice Burton; ii. Die Cumaceen der Norwegischen Expeditionen nach Ost-Grönland, 1929, 1930, 1931 und 1932, von C. Zimmer. Pp. 40. 2.50 kr. (Oslo: Jacob Dybwad.)

Nigeria. Tenth Annual Bulletin of the Agricultural Department, 1st August, 1931. Pp. ii+223+2 plates. (Lagos: Government Printer; London: Crown Agents for the Colonies.) 5*s.*

U.S. Department of Agriculture. Technical Bulletin No. 401: Descriptions of some Native Trypetid Flies, with Notes on their Habits. By Foster H. Benjamin. Pp. 96. (Washington, D.C.: Government Printing Office.) 10 cents.

Occasional Publications of the American Association for the Advancement of Science. No. 1: The Protection by Patents of Scientific Discoveries; Report of the Committee on Patents, Copyrights and Trade Marks. Pp. 40. (New York: The Science Press.) 50 cents.

Proceedings of the American Academy of Arts and Sciences. Vol. 69, No. 1: The Psammocharidæ of the Philippines. By Nathan Banks. Pp. 117. 1.60 dollars. Vol. 69, No. 2: The Rotation of Cobalt and Nickel by Magnetization and the Gyromagnetic Ratios of their Magnetic Elements. By S. J. Barnett. Pp. 119–135. 45 cents. Vol. 69, No. 3: The Vapor Pressure of Water, Part 2: Steam Research Program. By Leighton B. Smith, Frederick G. Keyes and Harold T. Gerry. Pp. 137–168. 65 cents. Vol. 69, No. 4: The Synthesis of Ammonia in the Electrodeless Discharge. By Walter C. Schumb and Louis Goldman. Pp. 169–188. 45 cents. (Boston, Mass.).

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