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Contemporary Alchemy.

IN another part of this issue we print the concluding part of Sir Ernest Rutherford's account of his researches on the disintegration of the atoms of some elements by means of α-rays. The theory of atomic structure which postulates a small positive nucleus and sparsely distributed surrounding electrons indicates that a permanent change in the atom requires the disruption of the nucleus itself. This nucleus is also, according to modern views, an association of simpler parts, probably only units of positive and of negative electricity, which are the same in all atoms. If this arrangement can be altered, we should change one atom into another, or others. The forces binding the components of the nuclei of stable atoms must be very great, and in overcoming them a large expenditure of energy will be required. The swift α-particle expelled from radium is by far the most concentrated source of energy known, and by firing these α-particles through matter, collisions with the atomic nuclei might be expected to break up the latter.

This is the idea on which the work is based, and it has now, as Sir Ernest explains, received remarkable experimental confirmation. He found that, with nitrogen gas, hydrogen atoms were liberated, but these did not appear with oxygen or carbon dioxide. Such particles are, of course, produced in hydrogen gas, or substances containing hydrogen, but simple precautions ensure that the hydrogen particles otherwise observed do not come from hydrogen existing as an impurity in the materials. The H-particles from hydrogen have a range in air of 30 cm., and by interposing mica screens equivalent to this absorption, no such particles are observed as scintillations on a zinc sulphide screen. With nitrogen interposed between the source of α-rays and the mica screen, however, numerous scintillations appear.

By placing a thin film of metal over the source of α-rays, and having oxygen between this and the screen, the production of H-particles from metals could be investigated. Solid compounds were dusted over gold foil, which itself gives no H-particles.

With the exception of helium, neon, and argon, all the elements up to atomic weight 40 were examined. In no cases except boron, nitrogen, fluorine, sodium, aluminium, and phosphorus were any H-particles observed. No element of atomic weight greater than phosphorus (31) gave any effect, but only particles of range not less than 32 cm. were sought.

A very striking result was observed in the case of aluminium, since nearly as many H-particles were shot off in the backward as in the forward direction of the colliding α-particles. This is explained by assuming that the H-particle in the aluminium atom is describing an orbit around the nucleus, when the direction of escape would depend on the relative positions of the α-particle and nucleus at the moment of collision with the satellite.

In the case of aluminium the maximum energy of the H-particle is 1·4 times that of the incident α-particle, and part of the energy must, therefore, have been derived from the nucleus itself. The disintegration is effected on an extremely minute scale; only about two α-particles in every million get near enough to the inner nucleus to dislodge an H-particle. If all the α-particles from 1 gram of radium were fired into aluminium, only one-thousandth of a cubic millimetre of hydrogen could be liberated in one year.

It has been surmised that the α-particle, or helium nucleus, of mass 4, is one of the units of which atoms are built up. The experiments referred to show that the hydrogen nucleus is also one of the units of structure, at least of some of the lighter elements. H-particles are only liberated from elements of atomic masses $4n+2$ or $4n+3$, where n is a whole number. Elements like oxygen and carbon, the atomic masses of which are $4n$, give no H-particles. This result would follow if the nuclei of the former elements are built up of helium nuclei, of mass 4, and hydrogen nuclei as satellites. The mass of the latter should not differ much from the free H-nucleus of mass 1·0077 in terms $O=16$, on account of the weaker binding of the satellite to the nucleus. If the nitrogen nucleus is made up of three helium nuclei of mass 12 and two hydrogen nuclei, the mass of the nitrogen atom should not be 14·00 but more nearly 14·01, as found by chemical methods. In the case of light elements the effective masses of the hydrogen nuclei should vary from 1·007 to 1·000 in different atoms, depending on the closeness of combination.

In earlier experiments particles of mass 3 with two positive charges appeared to have been liberated from oxygen and nitrogen. These, however, are now known to have their origin, at least in the case of oxygen, in the radioactive source and not in the volume of the gas.

We think it no exaggeration to say that these experiments are some of the most fundamental which have ever been made. It is not often that a scientific discovery excites interest outside the narrow circle of the laboratory or the scientific lecture-room. The discovery of radium by the Curies appealed to the larger world with a force which was equalled only by the profound interest aroused by the discovery of phosphorus by Brand in 1669, and of potassium by Davy in 1807, and so fundamental are the consequences of this new discovery that the intellectual world at large must follow with the keenest interest the progress of the experiments associated with the name of Rutherford. It was soon evident that increasing knowledge of the properties of radioactive substances was bound to alter fundamentally some of the cherished conceptions of the ancient science of chemistry. Sir William Ramsay held very tenaciously to the view that the immensely concentrated energy of the α-particle offered a means of testing that apparent simplicity of the chemical elements which they had succeeded in preserving, in trying circumstances, since the time of the alchemists. His experiments, however, could not at the time be convincing.

When Sir Ernest Rutherford went to Cambridge he had already made some progress in the most difficult task he has yet attempted. The means he used appear simple, as he describes them, but the experimental skill which was required to achieve these results is of a very high order. We feel sure that all our readers will join us in congratulating him on the work he is doing, and in expressing the hope that his further researches will continue to add to the splendid harvest of positive knowledge which is so rapidly growing under his hand.

It is obvious that the results so far achieved in this region are but the beginnings. There are many things we need to know, and some of the yet unsolved problems which suggest themselves may soon be cleared up by further researches. The chemist will be curious to know what is left when hydrogen is expelled from nitrogen, boron, aluminium, or other atoms. If boron is a mixture of two isotopes, of masses 10 and 11, these will be of the forms $4n+2$ and $4n+3$, both of which should give H-particles, as is found to be the case; but if lithium is a mixture of isotopes of 6 and 7, these ought also to give H-particles, although they were not detected under the conditions of experiment. If chlorine is a mixture of two isotopes, 35 and 37, the first is of the form $4n+3$, which should give H-particles, and the second of the form $4n+1$, which is not referred to by Sir Ernest Rutherford. Apparently, no H-particles were expelled from chlorine. This element, however, has an atomic mass higher than the limiting value 31, beyond which no H-particles were in any case found.

It may be that there is some change in the mode of building up the nucleus at this point, or, what seems more likely, that H-particles are, in fact, expelled, but are of such a range and velocity that they could not be detected in the present experiments. These difficulties will no doubt soon be cleared up, and we must await with such patience as we can the continuation of Sir Ernest Rutherford's work.

A History of Chemistry.

Die geschichtliche Entwicklung der Chemie. Von Dr. Eduard Färber. Pp. xii+312+4 plates. (Berlin: Julius Springer, 1921.) U.K., 312 marks; Germany, 78 marks.

DR. EDUARD FÄRBER'S "Historical Development of Chemistry" is one of those books that owe their existence to other books. It has been put together mainly with the aid of older works, more or less authoritative, on the subject of which it treats. As one turns over its pages, it is not difficult to trace the source of most of its statements. With the possible exception of the concluding section, which is concerned with the history of the present epoch, there is little evidence of original inquiry to be seen anywhere. Kopp and Lippmann have been drawn upon freely for the story of the rise and development of the chemical arts until the inception of phlogistonism, and Hoefer and Ostwald's "Klassiker," and Ostwald's "Lehrbuch der allgemeinen Chemie" have together furnished most of the material for the story up to the Revolution accomplished by Lavoisier and his co-workers. Much relating to the subsequent period has been gleaned from Kahlbaum's "Monographien," and from Hjelte's and Graebe's admirable histories of organic chemistry. For so much of the history of the progress of chemistry during what we may term our own epoch which has not yet been included in any systematic historical work, Dr. Färber has necessarily been driven for his information to special treatises, periodicals, and the published transactions and journals of the recognised chemical societies. To this extent he has certainly striven to exercise an independent judgment.

The works the author has consulted are excellent in their several ways, but it is well known to historiographers that much additional information has come to light on subjects which seemed adequately treated when certain of these works appeared. This is especially true of the earliest periods of chemical development. The researches of Egyptologists, for example, and the recent publication of works relating to Hindu and Chinese chemistry have made known many important facts concerning primitive operative processes essentially chemical in their nature. Manuscripts relating to later times have been discovered of which the existence was unsuspected. The real nature of others already known had not been revealed or was imperfectly understood. A more critical examination of ancient treatises has afforded new interpretations of what was obscure. Kopp's "Geschichte," published in 1843, when its author was barely of age, admirable as it is in many respects, has no longer the authority it enjoyed half a century ago. The "Beiträge," which appeared between 1869 and 1875, and the two volumes on "Die Alchemie in älterer und neuerer Zeit," based upon a fuller study of certain periods, no doubt supplemented and amplified the history. The "Entwicklung der Chemie in der neueren Zeit," printed and published in 1873 under the auspices of the Historical Commission of the Bavarian Academy, is but a fragment. It was written at a time of rapid change when Kopp was nearing the allotted span, and when his association with organic chemistry, never very intimate, was but slight. His editorial connection with Liebig's *Annalen* was probably the main source of his inspiration; certainly the Heidelberg atmosphere at that period had no quickening influence. Presumably Dr. Färber has been in a position to make use of this supplementary work. In any case, what is of permanent value in it has been incorporated in such later histories as that of Ernst von Meyer and of Ladenburg, but our author makes no mention of this additional matter.

It must be admitted that much of the information needed in the preparation of a history of chemistry that will comply with modern standards of historical research is not readily accessible. Some of it is scattered through publications comparatively unknown to the average professional chemist, as they seldom find their way into the ordinary chemical library. But some of this information has appeared in book form and is easily available, as, for example, Berthelot's "Les Origines d'Alchemie" and Roscoe and Harden's "New View of the Origin of Dalton's Atomic Theory," both of which works would seem to have escaped the author's notice.

Although the work is obviously a compilation—and it is but just to the author to state that he freely acknowledges his obligations by his abundant references to the sources of his statements—we by no means would imply that it is without merit. On the contrary, the general reader who is desirous of learning something of the rise and development of chemical science will find it of great interest, and most professed chemical students would widen their horizon considerably by an attentive perusal of its contents. It is written absolutely without bias and with an evident desire to present a well-proportioned and reasonably adequate account of the rise and progress of the science over the periods which the authors to whom the writer is mainly indebted have already traversed.

Considering that the book is intended for general reading, we venture to suggest that it would have added to its attractiveness if it were more freely illustrated. The interest of history is largely personal. The ordinary reader desires to know what manner of men they were who have collected the facts of chemistry, and formulated its theories. He wishes to learn something of their characteristics, where and how they laboured, and what were the conditions and circumstances under which their discoveries were made. This no doubt would have involved search, wide reading, insight, and power of characterisation, but it would have added greatly to the human interest of the work, and have imparted vitality and colour to what we are constrained to say is a rather bald and impassive story of human achievement.

The author attempts in some degree to meet what we suggest by reproducing a copy of a print belonging to the National Germanic Museum at Nuremberg representing an "Alchemist's Laboratory"; by a picture of Berzelius as a rather slim young man in knee-breeches, well-developed calves, court shoes and a tight, cut-away coat, seated in a well-upholstered chair, watching, whilst reading, a highly idealised piece of distillation-apparatus, heated by a Roman lamp—a picture reproduced from No. VII. of Kahlbaum's "Monographien." When one recalls the humble kitchen in the Swedish Academy's apartments which, under the despotic sway of old Anna the cook, served the great chemist as his laboratory, this representation of the well-groomed philosopher in the perfectly-appointed parlour provokes a smile. It is pleasing, but it is not history. More realistic is Prautschold's better-known drawing of the interior of the Giessen Laboratory as it appeared in 1842. It represents a crowded assemblage of workers who resemble the German students of opera-bouffe, but it is probably characteristic. As the names of those figured are known it would have added to the interest of the picture to have given them. Some of them at least are not unknown to fame. The remaining plate is a photographic reproduction of van't Hoff's private laboratory at Amsterdam, taken from Prof. Cohen's memoir. The illustrations are probably given as types of laboratories of their respective periods, but happier selections are available and might have been introduced.

The ideal history of chemistry has yet to be written. There already exist a number of works of the character of the one now noticed, but many of them are not much above the range of ordinary school histories. The subject is worthy of a fuller treatment; its several periods should be dealt with in special monographs and in the manner of professed historians. The story during the last 70 or 80 years—infinitely the most fascinating and the most fruitful period in its history—has not yet been adequately handled. But the man who could handle it most effectively is probably too busy in augmenting it.

T. E. THORPE.

Antarctic Polychæta.

Australasian Antarctic Expedition, 1911–14, under the Leadership of Sir Douglas Mawson. Scientific Reports: Series C—Zoology and Botany. Vol. 6, Part 3, Polychæta. By Dr. W. B. Benham. Pp. 128 + plates 6 + Map 1. (Sydney: Government Printing Office, 1921.) 12*s*.

THE labours of Kinberg, Grube, Ehlers, Gravier, Pixell, Ramsay, Benham (1909), and others, besides those described in the *Challenger* volume, have rendered us more or less familiar with some of the Antarctic Polychæts. The present memoir of Prof. Benham, an able and experienced observer, adds notably to our knowledge of such forms as have been obtained within the half-circle round the Antarctic land. The materials on which his report is based came chiefly from Commonwealth Bay, Adelie Land (Australian Antarctic), though a few were procured off Macquarie and Maria Islands and Tasmania, the collection containing fifty-eight species, of which eleven are new. In his summary of Antarctic forms hitherto obtained the author shows that the largest number of species belong to the Terebellidæ, followed in diminishing numbers by the Syllidæ, Phyllodocidæ, Aphroditidæ, Maldanidæ, Serpulidæ, and Sabellidæ, the other families having fewer numbers. Moreover, some species occur in large numbers, such as *Thelepus antarcticus*, *Harmothœ spinosa*, and *Potamilla antarctica*, a feature not uncommon in similar species in European waters. Of his new species, perhaps the most interesting is *Amythas membranifera*, from Commonwealth Bay, an Ampharetid which has an introversible frilled membrane instead of the usual oral tentacles.

The author has extended the distribution of various known species, as well as, by the aid of well-preserved examples, added to our knowledge of their structure, sexual variations, and otherwise. Careful investigation had led Prof. Benham occasionally to differ from his predecessors, but he shows fully and fairly the grounds on which his arguments rest; *e.g.* in the distinctions between Harmothoë and Hermadion. He does not enter into the structure of the foot in diagrammatic vertical section as Mr. Southern has done in the Indian forms from the Chilka Lake, probably because such is unnecessary in the discrimination of species, though it may be useful in critical cases. The careful methods adopted by Prof. Benham enabled him, for instance, to observe the chitinous supporting rod in the long metastomial cirri of *Pelagobia vigueri* which M. Gravier had overlooked. It may be open to doubt, however, whether his new species *Sphærodorum spissum* is not more closely connected with the European forms than is at present supposed.

This research still further emphasises the fact that no special polychæt fauna characterises the Antarctic seas, and that in all probability in the diatom-ooze of the great depths between Australia and the Antarctic shores even a proportionally greater number of novel types exist than have hitherto been procured. Again, some cosmopolitan forms make their appearance in the Antarctic waters, such as *Phyllodoce madeirensis, Glycera capitata, Cirratulus cirratus*, and *Serpula vermicularis*. It is curious, however, that *Hauchiella tribullata*, a Zetlandic Terebellid, is not included in the captures, though it was found at Kaiser Wilhelm Land in the American Antarctic region. The author did not meet with examples of the incubatory habit which was thought by Gravier to be a feature of these cold southern regions, *e.g.* in *Eteone gaini* and *Flabelligera mundata* amongst the polychæts, and in holothurians, actinians, and colonies of tunicates. It is well to remember, however, that the incubatory habit is seen in British seas from fishes to cœlenterates.

If criticism may be offered, it is that the author might have made the discrimination of his new and rare species more easily accomplished if he had given at the commencement of each a brief epitome of the specific characters. The accompanying ten plates have their figures fairly represented in lithographic ink, though they lack the fine touch of stone-engraving. The descriptive letters have been omitted from the figures throughout. The entire memoir is a credit to the Australian Government, and to Prof. Benham, whose ability and wide experience enabled him to treat the subject in an effective manner.

W. C. M'INTOSH.

European Archæology.

A Text-Book of European Archæology. By Prof. R. A. S. Macalister. Vol. 1, *The Palæolithic Period*. Pp. xv+610. (Cambridge: At the University Press, 1921.) 50*s*. net.

SEVENTY years ago the Scandinavian founders of European archæology regarded the shell-heaps or "kitchen-middens" as containing the earliest traces of man's handiwork. Ever since then it has been found necessary to shift man's beginnings further and further into the past, so that now Prof. Macalister is obliged to devote a whole volume, containing nearly 300,000 words, to reach the point at which his Scandinavian predecessors began their narratives. For the type of implement, in stone and in bone, found in the oldest shell-heaps the author adopts the recognised French term "Campignian," although he is of opinion that the culture represented in the shell-heaps was actually evolved in the Baltic Area. By a strange coincidence, if we are to follow our author implicitly, it is with the introduction of this shell-heap or Campignian culture into Ireland that the history of man commences in our sister-island. "No remains of the Palæolithic period to the end of the Magdalenian stage," writes Prof. Macalister, "have been found in the north of England or else in Scotland or in Ireland, some injudicious publications notwithstanding." The Professor of Celtic Archæology in University College, Dublin, has thus the advantage of surveying the ancient cultures of Europe from a land untrammelled by palæolithic tradition. His first volume covers cultural periods which are unrepresented in Ireland.

Where, when, and how, then, does the modern story of European archæology begin? One may reasonably complain of having to wade through some two hundred preliminary pages before reaching the point at which Prof. Macalister commences his archæological narrative. The first chapter is spent in defining what archæology is and what it is not; the second is devoted to the elements of geology, the third to the evolution and classification of mammals, the fourth to the evolution of man and classification of races, the fifth to eoliths and to *eolithists*, the name which the author gives to those who believe in eoliths as products of human hands. As the following passage shows, Prof. Macalister refuses to begin his archæological narrative with eoliths:—

"The question that these flints present to us is primarily: Are they the work of a conscious agent, fashioning them for a definite purpose, or are they not? The answer to this question appears to be almost wholly subjective, not objective, and is therefore outside the region of scientific study, except perhaps for the psychologist."

We fear that Prof. Macalister understands as little of psychology as of eoliths. For him, true archæology begins with types of flint implement which even a child can perceive have been artificially fashioned.

Archæology is construed in a wide sense by Prof. Macalister. It is made to include not only all things which have been made or used by past generations of mankind, but also skulls, bones, teeth, psychology, and religion. For a writer who warns his readers on almost every page against possible fallacies, it is somewhat daring for him to assert that "Man develops a religious instinct." Then, again, when discussing the "psychology of middle palæolithic man"—men of the Neanderthal type—he not only boldly asserts that they had a religion, but proceeds to draw a picture of this long dead and extinct type of humanity sitting round the fire and discussing momentous problems.

"One would tell of a dream that he had had, in which the dead had appeared to him; another would relate how something, he knew not what, but which surely was not of the common things of nature, had startled him when he was wandering abroad in the gloom of the forest" (p. 343).

Such fancies may find a place in a schoolboy's essay, but are altogether out of place in a massive work devoted to the archæology of Europe.

The illustrations, which are excellent and numerous, make up for much that is deficient in the text. Students will also be thankful for references to many recent papers and monographs. There is no doubt a real need for such a text-book as this written in English and designed for the use of students of archæology—a text-book to serve as a standard work. We only regret that the author, while displaying a most commendable and painstaking industry, has not risen to the height of his opportunity. A. K.

Indian Game-Birds.

The Game-Birds of India. By F. C. Stuart Baker. Vol. 1, *Ducks and their Allies (Swans, Geese, and Ducks).* Second edition. Pp. xvi + 340 + pl. xxx (4*l.* 4*s.* net.) Vol. 2, *Snipe, Bustards, and Sand-Grouse.* Pp. xvi + 328 + pl. xix (3*l.* 13*s.* 6*d.* net.) (Bombay: Bombay Natural History Society; London: J. Bale, Sons, and Danielsson, Ltd., 1921.)

THE first of these volumes, dealing with Ducks and their allies, is the second edition of a work published by the author in 1908, which again was a reprint from a series of articles which appeared in the Journal of the Bombay Natural History Society. The matter has therefore had the advantage of two revisions and is brought completely up to date as regards nomenclature and records. The second volume, now before us, deals with birds which are included by the sportsman among the game-birds, though in scientific classification they are not so. These are the Snipe, Bustards, and Sand-Grouse. Two further volumes are promised on the Pheasants and Partridges, and with these four by his side the Indian sportsman and amateur naturalist will be very completely equipped not only to identify the game-birds he commonly meets with, but to obtain all the information in regard to their habits and occurrence that is known. Mr. Baker, though now for some years retired from service in India, spent the greater part of his life there, and in these volumes he has given us much of his own observations and experiences; to these he has added contributions from others, both previously published and derived from information sent him by his many Indian correspondents. As a result we have here a most complete account of the life history of these favourite birds.

In every case a good description of adults and nestlings is followed by paragraphs on the distribution, nidification, and general habits, while every species is illustrated with coloured plates. These are most of them by Mr. H. Grönvold, though some of those in the first volume are from the brush of Mr. G. E. Lodge and the late Mr. J. G. Keulemans. They are reproduced by chromolithography in the case of the Ducks, and by the three-colour process in the second volume. The chromolithography is certainly softer, and perhaps gives a more artistic result. In the three-colour process the colours are decidedly sharper, and better defined, though the very shiny paper necessary for this process certainly detracts from their artistic appearance.

Perhaps one of the most interesting facts recorded in these volumes relates to the habits of two species of sand-grouse, *Pteroclurus alchatus* and *P. senegalensis* (formerly known as *P. exustus*). Although these birds inhabit the dryer and more desert regions of north-west India and Central Asia, they are, unlike some other desert forms, unable to do without water, and resort in enormous flocks to well-known watering-places at certain fixed hours to quench their thirst. It has always been stated by native shikarees that when they have young broods they convey water to them by thoroughly soaking the feathers and the breast and underparts, and that the young birds suck the water thus conveyed to them. This story has been confirmed by Mr. Meade Waldo, who has repeatedly bred *P. alchatus* and other species in confinement and has watched the process of the male saturating the feathers of his breast and subsequently satisfying the thirsty brood.

Nearly all intelligent travellers and even residents in tropical countries have experienced the irritation and annoyance of being unable to identify the strange forms of animal and vegetable life with which they come in contact. Such works as the present, with its beautiful series of coloured plates and carefully prepared descriptions, cannot fail to be of the greatest assistance to all those whom duty or pleasure take to India, and we must congratulate Mr. Baker and the Bombay Natural History Society on their enterprise in supplying two such fine volumes at a comparatively reasonable price as things are at present. We shall look forward to the appearance of the other two volumes promised within a reasonable period.

Water Flow in Pipes.

Hydraulics of Pipe Lines. By Prof. W. F. Durand. (The Glasgow Text Books of Civil Engineering.) Pp. xvi + 271. (London: Constable and Co., Ltd., 1921.) 18*s.*

THE subject of the flow of water in pipes and channels is not only of very considerable historical and scientific interest, but is also one of great practical and economic importance. It is frequently stated that hydraulics is an empirical science because water differs from the ideal fluid to such an extent that the theoretical hydrodynamical investigations are not of much value to the hydraulic engineer. While this in a measure is true and it is necessary to resort to experiments to determine the exact form of the formulæ which express the flow of water along pipes and the co-efficients to be used in them, nevertheless, there are many problems connected with the flow of water in mains which are capable of analytical treatment, and the volume under notice has for its principal aim the discussion of these problems.

In chapter 1 the general hydraulic principles of flow are discussed and empirical formulæ such as those of Chezy and Kutter are quoted, tables of co-efficients to be used with them for clean pipes being given. There is no attempt whatever to give particulars of modern researches, and so far as this chapter is concerned with loss of head by friction, no experimental work done during the last thirty-five years is considered worth mentioning. As regards losses by bends and elbows recent researches have been referred to, but no consideration is given to the very important question of the change in the carrying capacity of a pipe with time. The general principles are, however, clearly discussed, and it may fairly be said that this chapter is written as an introduction to the chapters which follow, in which the problems of the surge chamber and water hammer in pipe lines are very fully discussed.

The two succeeding chapters deal very fully with stresses in pipe lines, with the materials of construction, and with the design of pipes. The last chapter of the volume deals with the flow of oil along pipe lines. The important effect of temperature on the viscosity is emphasised and a curve is given showing how the pressure drop per mile can be obtained when the temperature is changing.

There are four appendices in which certain special theoretical problems are dealt with. In Appendix 1 the general theory of pipe line flow is considered from the theory of dimensions. In this connection it is surprising to an English reader to find no reference to Lord Raleigh, or to the work of Stanton and Pannell, or Lees, and throughout the whole book there is very little reference to much important work that has been done in this country. To English readers also such symbols as (*pf2*) and (*f3s*); meaning pounds per square foot and cubic feet per second respectively, may appear a little awkward, but the notation used throughout the book is summarised at the commencement. The work should prove of value to serious students of the subject.

F. C. L.

Recollections of a Geologist.

Memories of a Long Life. By the Rev. Canon T. G. Bonney. Pp. iv+112+vii. (Cambridge: Metcalfe and Co., Ltd., 1921.)

A LIMITED edition of this little book has been printed. It is meant primarily for Cambridge readers, but will be perused with affectionate interest by the many other friends of its author. It has also some wider appeal as the unaffected and revealing life-story of a last-century Don. Not many of us can aspire to a retrospect so gratifying in its entirety; and we congratulate the author on his enviable possession.

Beginning in 1837 with the hearing of minute guns on the death of William IV., the "Memories" cover a period of over eighty years (and are happily still continuing). Of the wide scientific achievements of their narrator they tell little, but are vivid with incidents and anecdotes of his boyhood, undergraduate days, and later professional life in Cambridge and London, with recollections of eminent men and abnormal weather. In the parlance of relativity, the events for the most part pertain to a particular system of reference and would scarcely be recognisable as events in another system; but they combine, within their limits, into a concordant and sharply individualised picture of a career "crowded with culture." They exhibit a life of continuous mental and bodily activity; terms of strenuous duty alternating with pleasant vacation tours in the Alps and elsewhere, usually fruitful in scientific results; and in their long range they recall the changes, both in material things and in mental outlook, that have become apparent during their course. It is a cheerful picture, in which we may occasionally catch the trace of vigorous old controversies that, like the little whirlwinds of hot weather, have now and again raised temporary commotion within the sphere of their impact without disturbing the broad serenity of the plain.

There is strong spice in the caustic remarks on the unseemly behaviour and dress of some of the undergraduates of to-day, and in the comments on the motor-car and bicycle, the latter of which "shoots out silently from hidden byeways, the rider never dreaming of using his bell." But the good-nature underlying it all is illuminated by the episode of a happening, years and years ago, when the author, then junior Dean, cleverly detected an undergraduate in a prankish breach of order in Chapel, and brought him before the Seniority with a stern demand on its unwilling members that "if you do not send him down you must appoint some one else to sit there in future, for I will not"—this Draconian severity being pressed for because "the penalty was not really so heavy as it seemed, for as I privately knew the man had just kept his term"!

The index should be read; it is an epitome of the book.

Our Bookshelf.

Der Torf. Von Prof. Dr. H. Puchner. (Enke's Bibliothek für Chemie und Technik unter Berücksichtigung der Volkswirtschaft: Band I.) Pp. xvi+355. (Stuttgart: Ferdinand Enke, 1920.) 40 marks.

PEAT is always an attractive subject for the investigator, and particularly for the inventor, as it seems to promise so much in return for so little effort. It lies on the surface and needs no expensive mining operations; it is often on the top of a hill and can be run down to the consumer by gravitation, and it is capable of yielding fuel, ammonia, and various oils by distillation or heating processes, for which it can itself provide the necessary energy.

The book under notice gives a useful summary of the properties of peat, especially of those studied by the German workers, and it will prove useful to prospective investigators who wish to know something of the nature of the material they have to handle. The great difficulty up to the present has been the drying: in its natural state peat may contain 90 per cent. or more of water, and this has to be reduced considerably before economic utilisation is possible. So far no method that is generally satisfactory seems to have been evolved. The author helps by giving an account of the methods adopted in Carinthia, Oldenburg, and elsewhere, as well as a list of methods proposed or used in factories where peat is converted into saleable products. The number of methods of utilisation suggested or actually tried is considerable. During the war attempts were made in Germany and Sweden to use it for firing railway engines, but it was found necessary to fill not only the tenders but also one or two waggons with fuel if any length of journey was contemplated. Much more successful are the efforts to convert peat into power gas, and one feels on looking through the book that the problem of utilisation of peat must surely be near its solution. It would certainly add to the resources of the world if satisfactory methods could be worked out.

The Homogeneous Electro-Thermic Effect. (*Including the Thomson Effect as a Special Case.*) By Carl Benedicks. (Ingeniörs Vetenskaps Akademiens: Handlingar Nr. 5, 1921.) Pp. 117. (Stockholm: A.-B. Svenska Teknologföreningens Förlag; London: Chapman and Hall, Ltd., 1921.) 15*s.* net.

THE Swedish Academy is issuing in English a series of memoirs on scientific subjects in order to make the work of Swedish men of science more widely known, and the volume under notice is the fifth to be issued. It deals with the transport of heat along a conductor through which an electric current is passing, and the author concludes from his measurements that there is, in addition to the Kelvin effect, a further flow of heat with or against the electric current even when the conductor is homogeneous and originally at a uniform temperature. His measurements are in general made on long cylinders, the centre of each being turned down to a narrow neck. The electric current through the neck causes a transport of heat to one or other side of the neck, and the difference of temperature of the two sides is measured by thermo-junctions. This difference does not vary with the magnitude of the electric current according to the same law as the Kelvin effect, nor is it always of the same sign as the latter. The author proposes to call this new effect "the homogeneous electro-thermic effect."

The Wisdom of the Beasts. By C. A. Strong. Pp. x+76. (London: Constable and Co., Ltd., 1921.) 5*s.* net.

THIS is not a zoological treatise on animal instincts and the like, but a series of philosophical fables of excellent humour—indeed the prefatory quotation from the Prologue to Phædrus' Book I. makes us shrewdly suspect the author of exquisite satire directed at relativity and other scientific concepts. The fable of "The Bird and the Fish" will cause amusement to the disciples of Einstein:—a young bird, inexperienced in the phenomenon of moving air and in its effects, is set thinking by the fact that on a certain day it took less time than usual to fly from the church steeple to the stream, and more than usual to make the return flight: after much cogitation it satisfies its philosophic soul thus:—"Ah! I have it at last; what has changed is not the field, but the clock. By flying away from a clock you alter its time-keeping so that it loses, and by flying towards it you alter its time-keeping so that it gains. The time-keeping of clocks is not a fixed and unalterable thing, but depends on whether you move or stand still." And such is the style of the majority of these fables.

Analyses and Energy Values of Foods. By Dr. R. H. A. Plimmer. Pp. 255. (London: H.M.S.O., 1921.) 6*s.* net.

THIS work, which was carried out for the War Office authorities, contains the most comprehensive series of food analyses performed in the British Isles. As the author points out, they are best regarded not as a replica of but as a supplement to the very complete set of data by Atwater and Bryant, U.S. Department of Agriculture. In some cases the number of analyses is not great, but since the results are from foods as actually supplied in Great Britain, they carry more weight in this country than more numerous figures published for other countries. The tables are very carefully arranged, so that the composition of the entire food, or any part of it, may be seen at a glance. There is also an excellent summary of analyses in a form suitable for calculation. Information is given regarding the methods employed, and a short appendix tabulates the common food stuffs which do, and also those which do not contain accessory food factors or vitamins. The volume undoubtedly represents a valuable and distinct advance in knowledge.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Science at the Post Office.

I HAVE always regarded expressions of opinion in the leading articles of NATURE as founded on ascertained facts impartially considered, and it is therefore with much regret that I feel impelled to protest against the article entitled "Science at the Post Office," which appears on the front page of your issue of April 1.

I shall try to put the writer's main contentions, and my replies to them, very briefly.

(1) *Complaints regarding the telephone service after the war are closely connected with the question of the technical qualifications of the engineering staff.*

This is not true in the sense intended to be conveyed. It is the easiest matter in the world to demonstrate that the complaints do not arise from any conditions involving science or research, but are due to the quite simple and commonplace fact that the home service had suffered for five years by the withdrawal of over 13,000 of its engineering staff for military duties, and by the loss of a large proportion of its experienced telephone operators.

The telephone system transferred to the State in 1912 was in urgent need of reconstruction and extension on a great scale. Such work on what may be called a living organism, and one very complex and sensitive, has to be carefully planned and executed. It was in full swing in 1914, when it had to be abandoned at the call of vital national necessity. Its resumption after the war was attended for some time by great and well-known difficulties in the supply of materials and in the retransformation of factories to peace conditions. It is now well in hand again. New operators have been trained, and what is needed to put things right is the construction of exchange buildings, switch-boards, and cable plant in adequate volume. The same conditions have applied to all nations involved in the war, and have no direct relation to the efficiency or scientific attainments of their engineering staffs. Nowhere was the post-war deterioration of telephone service more conspicuous than in the United States of America, although the depletion of telephone resources in that country lasted for less than half the time, and was proportionately very much less serious than in Great Britain.

(2) *A scheme, introduced in* 1907, *for recruiting* 25 *per cent. of P.O. engineers by open competition has remained in abeyance since* 1912, *and has now been replaced by a scheme whereby only* 20 *per cent. of new entrants will be obtained by open competition.*

The implication here is that standards of qualification, set up by a former Engineer-in-Chief, are now being reduced, but the facts are quite otherwise. There were good reasons for suspending the scheme in 1912, as practically the whole engineering staff of the National Telephone Company was then transferred to the Post Office, and had to be equitably absorbed in its engineering organisation. Since the war very few new appointments to the engineering classes have been made. The scheme of 1907 provided for the admission of college-trained youths by an examination considerably lower than that of an engineering university for a science degree. The present scheme requires all candidates to possess a science degree before they are eligible to sit for the competition for Assistant Engineerships, and the character of the examination is fully equal to the degree examination of the universities.

Another important point ignored in your article is that the present scheme has set up a separate open competitive examination, for which young men who have studied at universities and technical colleges are eligible. The character of this examination is a little lower than that for graduate Assistant Engineers, and successful competitors will be appointed as "Inspectors" in the Engineering Department. In this position they will be eligible, along with other selected Post Office employees, for a further series of competitive examinations for a further 20 per cent. of the vacancies for Assistant Engineerships (in the same subjects as in the examination for graduates but of a slightly less advanced grade) as well as for promotion in ordinary course. It is therefore a wide departure from the truth to say or imply that the proportion of full-time college men among recruits for Post Office engineerships has been limited to 20 per cent. And, quite apart from these outside recruits, I maintain emphatically that no man who is not, in the best sense of the word, a college student has any chance of appointment as a Post Office engineer. The fact that a man has had the grit and capacity to win his spurs by evening studies, extending over a period of many years, while following his daily employment is, to my mind, the reverse of a disqualification. Among the thousands of young men in the lower grades of the Post Office Engineering Department there exists a splendid recruiting ground for the higher positions. These men are selected with care in the first instance, and they are watched and reported on with equal care. They know that promotion depends on character and efficiency. The idea of "the field-marshal's baton" is rife among them, and I, for one, sincerely hope that the Post Office will always give it full encouragement. I have no fear of being charged, in any informed quarter, with belittling the need for mathematical and scientific attainments of the highest order in connection with the telegraph and telephone services. But the field of the Post Office Engineering Department is so wide that its everyday work calls for qualifications of many different kinds, and I speak from knowledge and experience when I say that the engineer who combines high character and business and administrative capacity with long Post Office training and continuous self-education is an officer of first-class practical value for whom there will always be abundant room.

(3) *The Chiefs of the Post Office Engineering Department should be men from outside the department, who have reached a position of eminence in the general engineering profession.*

I need not say much on this point. Two of my four Post Office predecessors in the position of Engineer-in-Chief, during the past thirty years have been Presidents of the Institution of Electrical Engineers, and others have only been prevented by the shortness of their term of office from attaining the same position. No one who understands the complexity of modern telegraph and telephone engineering will contest the statement that the position of Engineer-in-Chief will be better filled by the most highly qualified telegraph and telephone engineer and administrator in the country than by the most highly qualified general engineer. The American Bell Telephone Organisation is rightly held up to us as a model. In no case would the heads of that organisation dream of appointing a chief engineer who had not spent the main part of his lifetime in telephony. The senior ranks of the department—Assistant Engineer-in-Chief, Staff Engineers, and Superintending Engineers—contain many men much more fully qualified for the premier position by capacity, general and scientific education, and special engineering and administrative experience than any outside engineer could possibly be, and the Postmaster-General is to be congratulated upon the field of choice at his command. This is well known to the whole staff, and I need say nothing of the effect upon its *moral* and *esprit de corps* which would follow the adoption of the principle recommended in your article.

I am afraid I have already over-trespassed upon your valuable space, otherwise I could give much information as to the brilliant scientific work performed by Post Office engineers. Many of their productions are classics in the field of telegraph and telephone engineering and research.

The Post Office service is a "silent service," except when gratuitous and undeserved attack stings it into retort. I can without hesitation challenge any critic to produce experts in any branches of telegraph or telephone service who would not be at least equalled by Post Office officials whom I could name.

W. NOBLE,
Engineer-in-Chief.

General Post Office (West), London, E.C.1,
April 19.

SIR WILLIAM NOBLE places a construction upon the words used in our article which they cannot reasonably bear. The purpose was to direct attention to the Report from the Select Committee on the Telephone Service (1922), a document very generally admitted to be one of the most important and valuable of parliamentary papers issued in recent years; and we believe the article to which Sir William Noble refers to be a fair comment on a matter of great public interest. The Committee definitely says in this Report: "We cannot agree with the trend of Post Office evidence that from a telephone point of view the existing organisation works perfectly well, however cleverly managed it may be," and therefore substantially finds that there was good foundation for the complaints concerning the inefficiency of the Post Office telephone service: the Committee, in consequence, recommends a "*thorough reform*" (our italics) in the Post Office organisation. The minutes of the evidence taken by the Committee are contained in a public document (H.C. 191 of Session 1921), and therefore the names of the witnesses and particulars concerning them can be readily ascertained by those who so desire. Now, it is true that evidence was given by witnesses representing newspaper organisations, namely, the Press Association and the Newspaper Society; on the other hand, apart from the Post Office officials, the great majority of the other witnesses who came before the Select Committee attended in order to represent important organisations of various kinds, some fourteen in all, such as Chambers of Commerce, Agricultural Associations, and two Municipal Corporations. The general trend of the evidence of the latter witnesses amounted to a criticism of the quality of the telephone service, and although a great volume of the fault-finding was directed against the administrative system of the Post Office, many of the adverse comments made by the witnesses referred to work of a technical kind.

The volume in which the evidence in question is to be found was indicated in our article, and all who so desire can therefore consult the actual statements of witnesses as put on record therein, and can at the same time naturally draw their own conclusions in relation to the matters under investigation. We take, and have long taken, a deep interest in the utilisation of science in the public departments, and many sources of information on this matter are open to us; in consequence, we have considerable personal knowledge of the conditions prevailing in the technical branches of the various government departments, including the Post Office.

To deal with the first of Sir William Noble's contentions. We do not deny that during the period of the war the Post Office services had had to be carried on under exceptional difficulties. We also had information some time ago from American sources showing that the telephone service in America had deteriorated during the war period after the U.S.A. Government established its control upon the telephone undertakings; afterwards we learnt from American business men that the telephone service in their country began at once to improve as soon as the government control was removed, and was quickly brought again to a high level of efficiency. We fail, to see, however, the connection with the war situation alluded to by Sir William Noble in his letter, and the fact to which attention was directed in our article, namely, that foreign telegraph and telephone administrations have for a long time past demanded a higher standard of technical qualifications from applicants for positions in their engineering departments than has the Post Office.

As regards the second of Sir William Noble's contentions, we cannot understand how he arrives at the conclusion that the language employed in the reference in our article to the Post Office recruiting scheme of 1907 contains an implication that "standards of qualification, set up by a former engineer-in-chief, are now being reduced." The purport of our remarks on the subject is to the effect that we disapprove of a policy the consequence of which will be to reduce the percentage of engineers entering the Post Office by open competition below that represented by Post Office officials to the Select Committee of 1912—an extract from the Report of which is given in the article—as being then necessary. Our contention is that, responsible Post Office officials having stated publicly ten years ago, for the reasons given in the extract quoted, that it was "undesirable to limit the field of recruitment for the class of assistant engineers to those within the Department," and also that it was "important that 50 per cent. of the vacancies should be filled by young men of wider education and higher engineering attainments than are usual amongst Post Office servants," it cannot be right, and in the interests of the public service, now to reduce the percentage of engineers to be recruited by open competition to 20 per cent. only, as would appear to be the policy of the Post Office at the present time.

Within the limits of space at our disposal we are unable to go into details in connection with the method proposed for recruiting the subordinate grades of the Post Office engineering department: we were, of course, fully aware of the scheme outlined by Sir William Noble in his evidence before the Select Committee (Q. 2227); an opportunity may occur for dealing with the subject at a later date. However, it may be said at once that we fully recognise, and are in entire agreement with the view, that an avenue of promotion to the highest rank in the Post Office should be open to every *properly and sufficiently qualified* individual, irrespective of when or where he reaches the standard of qualifications essential to enable him *skilfully* to discharge the higher duties, and irrespective also of the grade in which he first entered the public service. But on account of the facilities, such as County Scholarships and otherwise, which are now open to every young man of ability, regardless of the means of his parents, for obtaining at an early age the highest standard of technical education available in this country, and for other reasons, we are of opinion—and our opinion is shared by important bodies representing the engineering profession—that the Post Office recruiting scheme outlined by Sir William Noble in his evidence is not of a kind which will best meet the needs of the situation, nor one which most effectively promotes the best interests of the State. Schemes of internal departmental examinations for promotion purposes are unsatisfactory; there is no guarantee that they will not be at some time reduced to a farce, *e.g.*, such as by allowing candidates to qualify in single subjects at relatively long intervals of time, and there are also other objections to such an arrangement.

As to Sir William Noble's third contention, we recognise, of course, that in the past the position of engineer-in-chief at the Post Office occasionally has been held by distinguished men, but we hold that quite a different stamp of early education and training is now required to produce the leaders who are to be called upon to devote their later years to administrative work in a technical sphere. Conditions have long passed the pioneer stage when knowledge had to be acquired and accumulated little by little, and day by day, in the course of daily work in order to build up materials for the science of one's particular branch of technology for the use of future generations of workers in that field. There are in the ranks of the Post Office engineers men of considerable technical ability, and nothing has been said to the contrary in these columns. But we are as averse to a government department relying for its reputation mainly on the eminence of one or more of its former chiefs, as we are to a young man claiming distinctions on the mere ground that one or more of his forebears was, or were, undoubtedly a man, or men, of brilliance. Further, one swallow does not make a summer, and, on the same principle, a small percentage only of able men in a large and complex department cannot possibly maintain it at a proper level of efficiency.

What we desire to see introduced is the method of selecting departmental chiefs indicated in our article, and the adoption of the procedure there recommended. We, therefore, cannot contemplate with the same satisfaction and equanimity, which Sir William Noble appears to do, the present situation. The status of the chief technical adviser in a government department dealing with the highly scientific and complicated problems associated with the telegraphs and telephones is at present considered to be equal in the matter of salary—the outward indication of status—to a position the importance of which is estimated to be one-half only of that of the chief administrative officer of the Department, and just about two-thirds of that of the administrative officer in the second position. We are consequently in agreement with the recommendations of the Select Committee which proposes the introduction in this country for the management and control of the technical services of the Post Office of an organisation similar to that of the Administrative Board of the Swedish Telegraph Department, and it is to be hoped that measures will be taken at the earliest possible date to carry out a thorough reform of the Post Office on the lines indicated in the Report of the Select Committee of 1922.

THE WRITER OF THE ARTICLE.

Discoveries in Tropical Medicine.

IN NATURE of April 29 there occurs, beginning at line 30 of page 549, the following statement: "The fact is that Manson's 'suggestion' that the Filaria of elephantiasis is actually carried by mosquitoes from the blood of one person to that of another remains to this day a 'suggestion.' It has not been established as a fact."

This statement is so strangely erroneous, both in concept and in fact, that were it not made in a letter professing to rescue truth from misrepresentation, written by one who in his own department of natural science has long enjoyed a commanding position, it would be kinder to all concerned to ignore it.

From the context it is evident that the term "filaria of elephantiasis" refers to the parasite known in pathology as *Filaria bancrofti*, this being the species responsible for a variety of pathological conditions in man, among which most pathologists, but not all, include elephantiasis.

Now in pathology the name *Filaria bancrofti* belongs to the adult worm, which lives not in the blood but in the *lymphatics*; we must assume therefore that by the expression "Filaria of elephantiasis . . . carried from the blood" is intended not the adult but the embryonic form of the worm—known to pathologists as *Microfilaria bancrofti*—which does occur in the *blood*.

Making these necessary assumptions, in the attempt to clarify an ambiguous statement, the interpretation is that a "suggestion" is extant that *Microfilaria bancrofti* is carried by mosquitoes from the blood of one person to that of another, and that this "suggestion" has not been proved.

Such a suggestion may have been made by some unimaginative individual; such an accidental mechanical transfer might conceivably occur; but since the microfilariæ cannot develop in the blood, their transfer from the blood of one person to the blood of another would throw no light on the question—how do the microfilariæ in the *blood* of one person become the filariæ in the *lymphatics* of another? The suggestion would remain—like Touchstone's shepherd's suggestion as to the cause of night—an idle and obtuse suggestion, not worth verification.

Any one acquainted with the facts and their implication, desirous of proclaiming the truth to readers of NATURE, who are not all parasitologists and pathologists, would not introduce an ambiguous term like "filaria of elephantiasis" into his text; for although *Filaria bancrofti*—which is the worm often associated with elephantiasis—is without doubt abundantly pathogenic to man in other ways, there are still some pathologists who are not convinced that it is responsible for the particular disease elephantiasis. The possibility should have been kept in mind of an inference being drawn that because some doubt still existed as to the full extent of its pathological significance the pathogenetic character of the filaria is still a matter of "suggestion"—a lamentably erroneous inference.

Readers of NATURE should have been informed that the whole history of *Filaria bancrofti* and its relations to man and to mosquitoes is to be found in text-books, some of them written by men who have themselves confirmed the facts and know at first hand what they are describing. To be brief: it has been known for many years that the microfilariæ floating in the bloodstream of an infected man are sucked up with his blood by mosquitoes of many kinds that bite him after sundown; that they get into the stomach of the mosquito, and thence into the insect's muscles, where they grow and develop; and finally, that as larvæ some of them get into the insect's proboscis, whence, when the insect bites other men, they escape on to the victim's skin and bore through into his lymphatics. Every stage has been followed, though naturally for the final stage the evidence is based—quite legitimately—on experiments in the laboratory with an analogous species of filaria.

The discoveries of those stages in this wonderful history that are passed in the stomach, muscles, and body-cavity of the mosquito, and of the necessary intermediation of the insect in the spreading of filarial disease among men, were made by a busy medical practitioner, working alone in China, in 1877. They were reported at a meeting of the Linnean Society held in March 1878; they were published in the zoology section of the Society's Journal for 1879; and an amplified account, with a plate of 46 figures representing every stage of the worm's development in the mosquito, from embryo in the stomach to larva in the body-cavity, subsequently appeared in the Transactions of the Society for 1884, at p. 367.

Not even the loneliest man, of course, works alone; as Carlyle says, "all past inventive men work with him there." But in workers there are varieties of aptitude and varieties of circumstance; and in discoveries there are varieties of worth. The discoveries of the highest class are those that enlarge the boundaries of science, that increase understanding, and open out new fields of action. The discoveries, worked out in unpromising circumstances, by that great original genius Patrick Manson, and reported to the Linnean Society in March 1878 and 1884, were of this kind: they established a great luminous principle of pathogenesis—the principle of the necessary intermediation of the bloodsucking insect: and of every man who applies this principle anew it may be truly said that always in the background Patrick Manson, may peace be with him—acknowledged or forgotten—"works with him there."

A. ALCOCK.

Nectar-Sipping Birds.

THE device of *Mirafra Assamica* to reach the nectar in the flowers of Castanospermum (noted in NATURE of April 15, p. 489) has its parallel among British birds. The blooms of several Asiatic species of rhododendron contain much honey, and many of these are defaced at this season by the great tit (*Parus major*), the blue tit (*P. cæruleus*), and probably the coal tit (*P. ater*) pecking holes in the tube of the corolla and tearing away the upper petals to get at the nectary. In some gardens bumble-bees have learnt to make a similar short cut to the nectary of *Salvia patens*; the legitimate entrance, which is furnished with a neat mechanism to ensure cross fertilisation by humming-birds or long-tongued Lepidoptera, being too narrow to permit access for Bombus. Knowledge of the trick, however, is not universal among bumble-bees; for I have found that in some gardens the blossoms of this Salvia remain intact.

HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

Aeroplane Crashes: The "Hole in the Air," the "Spin."

THE kind of accident in which Sir Ross Smith and Lieut. John Bennett lost their lives appears to be due to an attempt on the part of the pilot to change the direction in which the aeroplane is moving more abruptly than is consistent with its momentum. Suppose, for example, that the aeroplane could be instantly turned round to face the point from which it had come, its momentum would inevitably cause it to travel an appreciable distance tail first. An approach to this condition constitutes the "hole in the air" of the early airman, and is the harbinger of the "spin": it is the equivalent of "skidding" in the motor-car and is due to exactly the same cause, namely, momentum run riot.

As the motion of translation through the air (the one essential condition to the flight of heavier-than-air machines) is being lost the aeroplane begins to fall, and it is difficult to imagine that the pilot can do anything to arrest the fall except perhaps when it accidentally takes the form of a slanting nose-dive. Immunity from this class of accident can only be attained by judicious "banking" on curves of a radius suitable to the aeroplane and its velocity at the moment, and the complete avoidance of quick-turning movements undertaken for any purpose. Is it possible that in some aeroplanes the steering appliance is unnecessarily powerful and apt in that respect to deceive the pilot?

W. GALLOWAY.

The Athenæum, April 18.

DR. GALLOWAY directs attention to an important aspect of aviation in his reference to a recent accident. The type of failure—a spinning nose-dive—is unfortunately too common, and on any reasonable statistical basis may be expected to remain so until improved aeroplane design is achieved. Whilst rapid turning facilitates "spinning" the fundamental cause is peculiar to the aeroplane and a property of wing form and arrangement. The support for an aeroplane arises from the aerodynamic characteristics of the wings, and a fundamental change occurs when the angle of attack exceeds some 15 or 20 degrees. Above this critical angle the ordinary motion of an aeroplane is extremely unstable and the natural motion is a spin with the nose well down; the details of the instability are clear, but the remedy is unknown and only dimly foreseeable. The difficulty put before the pilot by the instability is accentuated by simultaneous loss or reversal of control. Scientific research is here required; it is, indeed, very urgently needed, but the prospects of obtaining the opportunity are far from good. Financial stringency and insufficient sympathy for research by the Air Ministry are the great difficulties, and not lack of scientific ability in the country. It is to be regretted that the loss of famous men is required to give point to a problem of long standing and that the Aeronautical Research Committee has not the necessary authority to carry out work which its reports show that it recognises as very important.

L. BAIRSTOW.

The Blood-cells of the Oyster.

THE blood-cells (leucocytes) of the oyster have been a subject of great interest ever since Lankester first observed them crawling on the outside of the body parts of the oyster. Recently I have found that these leucocytes will live for 3 or 4 days in sea-water in dishes. If the leucocytes be set free by teasing up the heart of an oyster or by placing pieces of the palps or bases of the gills in sea-water in a petri dish, they are seen at first to be aggregated mainly in masses, but within ten minutes to half-an-hour it will be found that the leucocytes are spread over a large portion of the dish and creeping away from the masses in a flattened amœboid condition on the bottom of the dish or even on the surface film. At the end of 3 or 4 days the cells round off and die. The length of time they remain alive, however, should make these leucocytes—which are very easily obtainable—valuable as subjects for physiological investigations, and further, suggests that it might be possible to *cultivate* them in an appropriate medium under appropriate conditions.

The mode of propagation of leucocytes in oysters is not known, and certainly no definite organ is known to produce them. A division of a living leucocyte has been observed to the extent that the resulting halves could be seen to be separated only by a relatively very long and very fine connecting thread, which was finally lost sight of; but a complete division could not be stated to have been seen in this case, and other observations point to the formation of long protoplasmic connexions between the leucocytes of the oyster as a repair phenomenon somewhat equivalent to the clotting effect of blood in vertebrates. The cultivation of the leucocytes of the oyster may nevertheless be possible, since Carrel and Burrows and later workers have shown that even specialised tissues of vertebrates can be grown outside the body in media and under conditions now well-known. A successful cultivation of the leucocytes of the oyster would undoubtedly suggest methods of attacking the problem of the cultivation of human leucocytes outside the body under known conditions and to yield known properties in the leucocytes. The potentialities of human leucocytes cultivated under such conditions may be so great that sufficient excuse is provided for any speculation which may point even faintly to a method by which such a desirable product may be attained.

J. H. ORTON.

The Marine Biological Laboratory, The Hoe, Plymouth, April 28.

Periodical Phenomena in the Temperature Functions of Certain Properties of the Metals.

IT is well known that the assumption of a quantum distribution of the energy of vibrations of the atoms in solids can be used to explain changes of the specific heat and other properties at low temperatures. Now this quantum distribution also seems to reveal itself in a more direct manner.

I have measured, partly in collaboration with Mr. F. Gunneson, the thermoelectric force at the ordinary temperature of specimens of iron and tungsten that had been successively heated at different temperatures and each time rapidly cooled. The thermoelectric force taken as a function of the heating temperature shows periodical changes, and I could easily distinguish certain repeated intervals of transformation. The approximative absolute temperature, T_n, of transformation, satisfies the relation $T_n = A . n$, where A is a constant and n an integer number. This relation has been verified experimentally for iron from $n=3$ to 12, and for tungsten from $n=4$ to 9. The mean value found for A was for pure iron 97° and for tungsten 82°.

As remarked above, this phenomenon is most probably due to the quantum distribution of vibration energy. As the mean number of quanta of the atoms, however, increases continually with the temperature, I have assumed, to explain the periodicities, that the transformations occur at every temperature for which a certain fractional part $(1/r)$ of the atoms has a number of quanta like, or greater than, a new integer. This assumption gives $A = \theta/3 \log r$, where $\theta (= \beta\nu)$ is the characteristic temperature of the metal in consideration. From this relation r may approximately be calculated, though the values are, like those of θ, rather uncertain. I found for iron $r = 4 \cdot 6$, and for tungsten $r = 3 \cdot 3$. Thus the critical fractional part is about one-fourth, which seems to be a reasonable value.

G. BORELIUS.

Physical Institute, University, Lund.

Observation of Comets.

Dr. Crommelin in his valuable "Comet Notes," *B.A.A. Journal*, March 1922, p. 198, speaking of Reid's comet (1922 *a*), says "the comet must have been quite well placed for Northern observers last October and November, being of the 9th magnitude." It seems that Mr. Reid discovered the comet only a short time before it passed out of sight. This incident reminds us of the fact that a considerable number of these objects must escape observation altogether owing to the want of observers. It is remarkable that English astronomers appear hitherto to have taken little interest in cometary work, and that very few comets have been discovered from this country.

This is a regrettable circumstance. Yet the discovery and observation of comets include a comparatively easy and very attractive field of work open to amateurs with moderately powerful instruments. There are a great number of telescopic observers in the United Kingdom who have the means and the time at their disposal to accomplish valuable work in this department if they would only engage in it in an earnest manner. It is a branch which offers special inducements to amateurs, and holds out a greater prospect of brilliant success than perhaps any other sphere of labour. It is hoped, therefore, that some enthusiasts will turn their practical attention to it, for it is fair to suppose that some of them would like to follow in the footsteps of Messier and Pons, and the equally famous modern discoverers of comets, Barnard and Brooks.

The cometary section of the B.A.A. could not have a more capable director than Dr. Crommelin, and it would strengthen his hands, provide material for his researches, and repay him for his labours if the members of the section notified him of their discovery of one or two comets every year.

W. F. DENNING.

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A Proposed Laboratory Test of the Theory of Relativity.

I SHOULD like to comment on the assumption as to the atomic weight of RaG made by Dr. King in his letter in NATURE of May 6, p. 582. Instead of taking this as known, and calculating the atomic weight of radium by taking account of the α-particle, energy and electron masses, it appears to me that the reverse process would be more justified. It is true that there is an unexplained discrepancy in the difference between the atomic weights of uranium and radium, but we have no reason to doubt the value of the atomic weight of radium obtained by Hönigschmid. As his radium was obtained from Joachimstal pitchblende, which contains practically no thorium, there is no liability to disturbance from the presence of isotopes of radium in his material. On the other hand, the theoretical atomic weight of RaG was obtained by subtracting the mass of five α-particles from the atomic weight of Ra. That the lowest value (206·046) found by Hönigschmid for lead from Morogoro pitchblende agrees so nearly with the theoretical value (205·93), shows only that the amount of original lead present in this material was very small, although, of course, it gave splendid confirmation to the theory of isotopy. We cannot say, however, that we are dealing with *pure* RaG, even though we know that the amount of admixed isotopes must be very small.

In dealing with such small corrections to the atomic weight as are involved in Dr. King's letter, it thus appears unjustifiable to start off by assuming that the atomic weight of RaG is 206·00. As Dr. King suggests, however, when the technique of the determination of mass spectra has developed, we shall be independent of admixed isotopes, and the problem will then be put to a rigorous test.

ROBERT W. LAWSON.

The University, Sheffield.

Artificial Disintegration of the Elements.[1]

By SIR ERNEST RUTHERFORD, F.R.S.

ABSORPTION CURVES IN NITROGEN AND ALUMINIUM.

The variation in the number of scintillations as the absorption in the path of the rays increases from 10 cm. is shown in Fig. 1. The source of α-rays is in all cases radium-*C*. Curve *A* shows the effect in nitrogen (air) where the maximum range is 40 cm. Curve *B* is the corresponding absorption curve for a mixture of hydrogen and carbon dioxide, about 1 volume of hydrogen to 1·5 of carbon dioxide, which gives the same stopping power as air for α-rays. The number of scintillations due to hydrogen is very great in this case for absorptions less than 20 cm., but falls off rapidly, and none could be distinguished beyond 30 cm. Curve *C* gives the natural effect when the air is replaced by dry oxygen. This is small compared with that observed in nitrogen. Curve *D* shows the effect when an aluminium plate of 3·5 cm. stopping power is placed over the source and the air replaced by oxygen. Thus the particles liberated from aluminium are able to penetrate a much greater thickness than the particles from hydrogen or nitrogen.

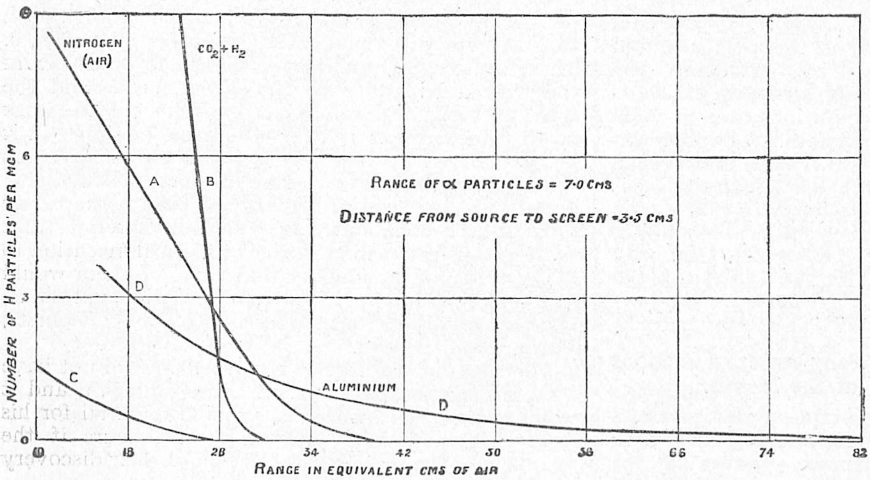

FIG. 1.

It is a matter of great interest to find how the absorption curves for these long-range particles vary with the velocity of the bombarding α-particles. This has been examined for two typical elements, nitrogen and aluminium, and the results for the latter are shown in Fig. 2. It was found that to a first approximation the maximum range of the particles liberated from an element was proportional to the range of the bombarding particles. In all cases, the number of scintillations falls off rapidly as the velocity of the α-particles is decreased. The effect of velocity is specially marked in aluminium, and few, if any, particles are observed when the range of the α-particles is reduced to 4·9 cm. of air. The effect shown in curve *D* (Fig. 2) is due almost entirely to the "natural" scintillations from the source. When we remember that the decrease in velocity corresponding with the reduction of the range of an α-particle from 7 cm. to 4·9 cm. is only 11 per cent., we see how rapidly the number falls off with lowering of the velocity. It seems likely that no disintegration can be effected in the case of aluminium if the velocity of the α-particle falls below a certain critical value. This is not easy to prove conclusively, but, if correct, it indicates that the α-particle must have a certain critical energy to release an H-atom from the nucleus.

A very striking result was observed in the case of aluminium. It is to be expected that the liberated particles should for the most part be projected in the direction of the bombarding α-particles. Actually, it was found, however, that nearly as many were shot in the backward as in the forward direction. No evidence of such an effect was observed in the case of the nitrogen particles. The other elements have not yet been examined from this point of view, but we should expect an element like phosphorus, which gives rise to long-range particles, to show a similar effect. A possible explanation of this striking result will be given later.

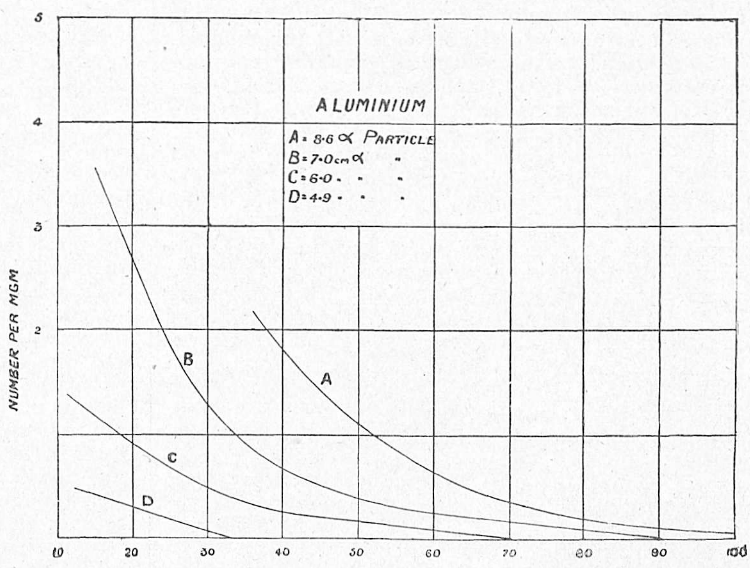

FIG. 2.

NATURE OF THE EXPELLED PARTICLES.

It can be shown readily that the long-range particles

[1] Continued from p. 586.

liberated from the elements are deflected by a strong magnetic field. By the adoption of special methods, it has been found possible to compare the amount of deflexion of these particles with that shown by the swift H-atoms produced when α-particles pass through ordinary hydrogen. It was found that the particles from nitrogen were deflected to about the same extent as the H-particles from hydrogen, and behaved in all respects like swift H-atoms carrying a positive charge. It seemed likely from the first that the corresponding particles from fluorine, phosphorus, and aluminium would also prove to be H-atoms liberated from the nuclei at speeds depending on the nature of the element and the velocity of the impinging particle. This has been confirmed in recent experiments by Dr. Chadwick and myself by a method similar to that employed for nitrogen. The bending of the particles in a magnetic field was determined for an absorption greater than 32 cm. of air, in order that the experiments should not be complicated by the possible presence of hydrogen contamination in the material under examination. The experiments were not easy on account of the small number of particles present under the experimental conditions and it was found necessary to devise a special microscope with a large field of view to carry out the investigation. The experiments were all in accord with the view that the particles from fluorine, phosphorus, and aluminium are swift atoms of hydrogen, and we may conclude that in each case an H-atom is liberated from the nuclei of these elements.

The maximum speed of ejection of the H-atom from the different elements can be estimated approximately by assuming that the law connecting the velocity and range of the α-particle holds also for the H-atom, namely, that the velocity is proportional to the cube root of the range. It has been calculated, and also confirmed by experiment, that the maximum speed communicated to a free H-atom by a head-on collision with an α-particle of velocity V is $1\cdot6V$, while its range in air is about 28 cm. Consequently, the maximum velocity of the H-atom from nitrogen, which has a range 40 cm., is $1\cdot8V$, and that from aluminium, with a range of 90 cm., $2\cdot37V$. The α-particle communicates 0·64 of its energy to a free H-atom in a direct collision, and it can be calculated that all H-atoms which have a range greater than about 56 cm. are projected with energy greater than that of the bombarding α-particle. In the case of aluminium, the maximum energy of the H-atom is 1·4 times that of the incident α-particle. This is a very interesting result, showing that in some cases there is actually a gain of energy as a result of the disintegration of the aluminium nucleus. We must therefore conclude that at any rate for all collisions in which the liberated H-atom has a range greater than 56 cm. of air, a part of the energy of the H-atom is derived from the disintegrated nucleus. This is analogous in some respects to the well-known gain of energy in the escape of an a-particle from a radioactive nucleus.

It must be borne in mind that the amount of disintegration effected by the α-particles is on an excessively minute scale. When a particle from radium-C passes through aluminium, it probably passes through the electronic structure of about 100,000 atoms, but only about two α-particles in every million get near enough to the inner nucleus to effect the liberation of an H-atom. We know that the collected α-particles from 1 gram of radium give rise to 163 cubic mm. of helium per year. If we suppose that all the α-particles from 1 gram of radium were fired into aluminium, the amount of hydrogen liberated by the disintegration of the aluminium nuclei could not be more than 1/1000 of a cubic millimetre per year. The amount of hydrogen liberated under possible experimental conditions is thus almost beyond the means of detection by ordinary chemical methods. It has only been possible to study the disintegration by the use of such a delicate method that each H-atom set free produces a visible scintillation on a zinc sulphide screen.

MECHANISM OF DISINTEGRATION.

From a study of radioactivity, it has been surmised that the α-particle or helium nucleus of mass 4 is one of the units of which the atoms are built up. The experiments referred to in this lecture gave the first definite proof that the hydrogen nucleus also is one of the units of the structure of some of the lighter elements. It is of interest to note that H-atoms are only liberated from elements the atomic masses of which are given by $4n+2$ or $4n+3$, where n is a whole number. Elements like carbon and oxygen, the atomic masses of which are given by $4n$, are not affected. This is shown in the following table:—

Element.	Mass.	$4n+a$.
Boron	11	$2\times4+3$
Nitrogen	14	$3\times4+2$
Fluorine	19	$4\times4+3$
Sodium	23	$5\times4+3$
Aluminium	27	$6\times4+3$
Phosphorus	31	$7\times4+3$

This result is to be anticipated if the nuclei of these elements are built up of helium nuclei of mass 4 and hydrogen nuclei. In order to account for the liberation of an H-atom from these elements, it is natural to suppose that the H-nuclei are satellites of the main nucleus. If the satellite is not too close to the latter, the α-particle in a close collision is able to give the satellite sufficient energy to allow it to escape from the system. It is to be anticipated that the H-satellites are closer to the nucleus in the case of aluminium than in the case of nitrogen, and that consequently more energy is necessary in the case of aluminium to effect their release. It is of interest to note that the chance of liberating a swift H-atom from nitrogen is not more than 1/20 of the chance of setting a free H-atom in corresponding motion. This indicates that it is probably only within certain prescribed limits of velocity of the satellite and position with regard to the central nucleus that the liberation of the satellite is possible.

We have already referred to the fact that the H-atoms from aluminium appear to be released in all directions. Actually, however, the velocity in the backward direction of the α-particles is distinctly less than in the forward direction. Such a result at first suggests that the α-particle acts the part of a detonator to the aluminium nucleus and that the energy of the escaping fragments is mainly derived from the nucleus. I think, however, that the following explanation is more probable and in better agreement with experiment.

If we suppose that the H-satellite is describing an orbit round the central nucleus, the direction of escape will depend on the relative position of the α-particle and nucleus at the moment of the close collision with the satellite. In the collision shown in

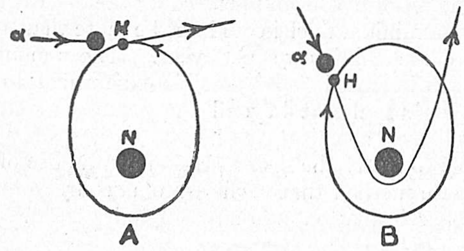

FIG. 3.

Fig. 3, *A*, for example, the H-atom will escape in the forward direction of the α-particle; in the collision (Fig. 3, *B*) the H-atom will describe an orbit round the nucleus and escape in the backward direction. The velocity imparted to the residual nucleus in the forward direction is much greater in the latter than in the former case. Such a view assumes that the forces between the positively charged satellite and nucleus are attractive instead of repulsive very close to the nucleus. This change of sign of the forces seems very probable at short distances from the nucleus, for otherwise it is difficult to understand how a positively charged complex nucleus can hold together.

Another consequence of some interest follows from the possibility of releasing H-atoms from light elements. It is generally supposed, although it is very difficult to obtain direct proof, that the helium nucleus is composed of four hydrogen nuclei and two electrons. In this combination there is a loss of mass, and this is ascribed to the very close combination of the structural units. On modern views of the relation between mass and energy, it follows that the energy liberated in the formation of a helium nucleus is more than three times the energy of the swiftest α-particle from radium. We should consequently not expect to be able to break up a helium nucleus with an ordinary α-particle, and this is in agreement with experiment so far as it has gone. In fact, the helium nucleus would appear to be the most stable of all nuclei.

Since, however, in the case of nitrogen, for example, we are able to release an H-atom by means of a slow α-particle, it seems clear that the H-satellite is not bound nearly so closely in the nitrogen nucleus as in the case of the helium nucleus. The change of mass due to the emission of energy in binding the H-satellite should consequently be much less than in the case of helium. The mass of the satellite should not differ much from the free H-nucleus of mass 1·0077 in terms of $O=16$.

If it be supposed that the nitrogen nucleus, for example, is made up of three helium nuclei of total mass 12 and two hydrogen nuclei, the mass of the nitrogen atom should not be exactly 14·00, but more nearly 14·01. In the case of the light elements, it appears probable that the effective mass of the protons composing the nuclei will vary in different atoms from about 1·007 to 1·000, depending on the closeness of the combination. Consequently, we should expect that the whole number rule found by Aston, which appears to hold for atomic masses to about 1 in 1000, would be departed from if measurements could be made with still further accuracy.

The next question which arises is whether any other particles beside that of hydrogen can be released by α-ray bombardment. Some time ago, I found that when radium-*C* was used as a source a small number of bright scintillations were observed, which had a maximum range in air of about 9 cm. It was natural at first to suppose that these were due to a new type of α-rays from the radioactive source. The effect, however, of aluminium screens in reducing the range of these particles led me at first to believe they were generated in the volume of the gases used, namely, nitrogen and oxygen. By comparing the bending of these rays in a magnetic field with that of H-particles from hydrogen, I concluded that they must be atoms of mass about 3 carrying two positive charges. Later experiments have brought home to me the untrustworthiness of this method of fixing the source of the radiation on account of the marked variation in thickness of films of metal foil. Using a more direct and simpler method, I have recently convinced myself that, at any rate in the case of oxygen, the particles have their origin in the radioactive source and not in the volume of the surrounding gas. Under such conditions, the comparative method of estimating the mass of the particles is no longer trustworthy. While a large amount of experiment will be required to fix definitely the nature of the radiation, the general evidence indicates that it consists of particles of mass 4, which are projected from the source and represent a new mode of transformation of radium-*C*.

By the methods outlined we can hope to detect only particles which travel a distance greater than the primary α-particles. If, however, a disintegration of an element should occur in which a massive particle is liberated, it is quite probable that the latter may have a range shorter than the α-particle. To examine cases of this kind, we can utilise the beautiful method developed by Mr. C. T. R. Wilson for showing the trails of ionising particles. Some experiments of this kind by a modified method have been made by Mr. Shimizu in the Cavendish Laboratory. A number of photographs showing well-marked tracks near the end of the range of the particle have been obtained. Until, however, these photographs are accurately measured up and compared with one another, it is difficult to be certain whether or not these branching tracks can be explained by collisions of the α-particle with the nuclei of nitrogen or oxygen. It seems clear, however, that the nuclei involved can travel considerable distances through the gas before being absorbed. If a large number of photographs be taken, it should be possible to settle definitely whether any collisions involving the disruption of atoms occur and to determine the probability of their occurrence. This direct method of attack of the problem, whilst laborious, should give very valuable information on this point.

It appears not improbable that the α-particle may occasionally be able to disrupt a helium atom from a complex nucleus like carbon or oxygen, which are believed to be composed of three and four helium nuclei respectively. The fact that the mass of these atoms is nearly an integral multiple of the helium atom suggests that the helium nuclei are bound together with much weaker forces than the H-components of the helium nucleus itself. If the structure of the complex nucleus, say, of oxygen is such that the α-particle may communicate a considerable fraction of its momentum and energy to a single component, we should expect such disintegration to occur. It is also possible that charged particles of mass about 2 or 3 may exist as secondary building units of the complex nuclei of some elements, but so far no definite evidence of their liberation has been obtained.

I have so far confined my remarks to the disintegrating effects of swift α-rays, but it is important to consider whether the swift β-rays or energetic γ-rays from radium are able to produce any effect. We have found that neither β- nor γ-rays appear to have the power of giving sufficient energy to a free H-atom in ordinary hydrogen to detect it by the scintillation method, and consequently still less should we expect these rays to liberate a swift H-atom from a complex nucleus. It is possible, however, that these agencies, and particularly γ-rays of very short wave-length, may be able to liberate an electron and lead in this way to a change of its atomic number. Unless, however, the resulting atom is unstable and breaks up with the emission of a swift particle of the α-ray type, it will be difficult to be certain of such transformations. It should be noted that Slater has shown that α-rays are able to excite some very penetrating rays in their passage through ordinary matter. There is some evidence that such high-frequency radiation can only arise from the nuclei of atoms. If this be the case, it may be possible that the α-rays in some cases lead to a liberation of a β-particle from the nucleus and a consequent transformation. This effect, however, must be on a very small scale.

Many attempts have been made in the past to test whether the ordinary atoms can be disintegrated by special agencies. The late Sir William Ramsay, with the characteristic instinct for choosing the best line of attack, made a number of experiments on the effect of the α-rays of radium on matter and concluded that he had obtained evidence of the production of neon from water and the liberation of lithium from copper. These conclusions have not been confirmed by subsequent investigators, and in the light of the experiments described in this lecture it seems very doubtful whether the amount of transformation, even if it occurred, would be sufficient to be detected by ordinary chemical methods such as were employed.

Many instances have been recorded of the appearance of helium in discharge tubes, and it has been suggested that helium is a product of the transformation of the electrodes by the action of the intense electric discharges. The most notable experiments in this direction have been made by Prof. Collie, but the subsequent detailed investigations by Strutt did not confirm his conclusions. It is exceedingly difficult to prove that the appearance of helium is not due to its occlusion in the electrodes and liberation by the intense heating of the discharge. Similarly, many observations have been made of the steady liberation of hydrogen from electrodes. Winchester, who examined this effect in detail with thin aluminium electrodes, found that hydrogen was released until the electrodes were entirely dissipated. It is very difficult to believe that this hydrogen is a product of the transformation of aluminium when we remember the great energy of the α-particle required to effect it. As in the case of helium, it seems more probable that the hydrogen was originally absorbed in the electrodes.

While it is unsafe to be dogmatic on these points, the general evidence indicates that the atoms as a rule are such stable structures and the nuclei are held together by such powerful forces that only a most concentrated source of energy, such as the α-particle, is likely to be effective in an attack on such well-protected structures. Even when disintegration takes place, it is on an exceedingly minute scale, and only a few α-particles in a million are effective. If we had charged atoms available of ten times the energy of the α-particle from radium, we could probably penetrate the nuclear structure of all atoms and occasionally effect their disintegration.

Organisation for Visual Instruction.

By DR. C. W. KIMMINS, Chairman of the Cinema Education Committee.

A BULLETIN on the subject of visual instruction recently received from the University of Wisconsin is of great value as showing the remarkable results which have been obtained by the collection and distribution on an elaborate scale of material for the development of this method of teaching. The fact that in Wisconsin "the circuit plan of distribution" has been in operation for six years "with increasingly gratifying results," enables the authorities to speak with great weight on the subject. The Bulletin deals not only in considerable detail with every department of the organisation, but also gives valuable suggestions for overcoming difficulties such as the transport, storage, and repairing of films and lantern slides. An idea of the great importance attached to visual instruction by the University may be obtained from the fact that a room in the University extension building has been fitted up and equipped with stereopticons, motion-picture machines, and projection apparatus of many of the leading makes. Teachers and committees are invited to visit Madison at any time to inspect these machines side by side and compare their respective merits with one another. It is also possible at the same time to become better acquainted with the visual instruction plans and purposes of the university extension division as well as with the stock of material.

In the British Isles the useful part which visual instruction can play in educational methods has long been recognised, as is evidenced by the action of the more important local education authorities in providing the schools with lanterns, lantern slides, pictures, maps, diagrams, botanical and other specimens, and a variety of other material for this purpose. The Lantern Slide Committee of the London County Council has done valuable work for many years in the preparation of a magnificent collection of lantern slides suitable for the illustration of lessons in various subjects. The catalogue of slides is frequently revised and ample provision is made for their distribution, of which full advantage is taken by the schools. The modern school, moreover, is generally equipped with a room, which is in constant use, specially designed for lantern illustrations. Thus, so far as the lantern is concerned, the schools have been generously treated.

The kinematograph film, however, is being used for educational purposes far more in America than in our own country. This is especially the case with adult education, in which the problem is an infinitely simpler matter than is that of the introduction of the kinema into the school for the normal purposes of instruction, in which a good case must be made for its value as against its competitor, the lantern.

There is no difficulty with propaganda films for various purposes, films dealing with general questions of health, those dealing with advanced science and specific industries, farming operations, general travel, and so on, provided always that they are prepared under the supervision of experts who are responsible for the sub-titles or captions. All are agreed on their value and great educational possibilities. They have, moreover, the advantage of being self-contained; each film tells its own, more or less complete, story. The difficulty begins when the film is used for continuous visual instruction in the general curriculum of the school.

The most promising feature of the situation as regards America is that the whole subject is being taken up by the universities, as is made abundantly clear by the Bulletin. The university extension division of the American university is a very important department, and being so intimately concerned with the extra-mural teaching of the adult, it comes into far closer personal touch with the schools than our own universities. The fact that in the Wisconsin experiment the majority of the films on educational subjects are edited by university professors is of far-reaching importance. The necessity for the collaboration of the expert and the film producer is emphasised in the Bulletin.

An admirable film was recently produced on a biological subject which would have much greater value and could be used with greater satisfaction if it were free from biological errors—errors that would not have crept in had its production been aided in and censored by men from the biology department of one of our universities. Illustrations could be multiplied almost indefinitely of films of the highest educational value that could be produced in the university and with the aid of the university staff.

What is generally known in this country as the educational film, suffers under the grave disadvantage of having to serve two purposes. It has to be of a sufficiently popular nature to be acceptable to the normal patron of the kinema theatre, and at the same time to contain sufficient material of scientific interest to appeal to the person who has a fair background of knowledge of the subject. To serve this dual purpose many beautiful films have been prepared at great cost to the producer, but they have not met with sufficient popular favour to stimulate the further production of this type of film. During the sitting of the Cinema Commission many teachers who appeared as witnesses said that the kinema might be used with great advantage in teaching such subjects as nature study and geography.

The difficulty of a dual purpose to be served has also been experienced in America, as is shown by the following extracts from the Bulletin:

(1) We therefore have two rather distinct classes of borrowers—the schools on one hand, calling for material to use in formal class-room work, and on the other civic and community organisations of many sorts, whose needs and desires differ from one another to a greater or less degree and in particular from the somewhat stereotyped needs of the schools.

(2) The class approach to the study of a topic through the aid of slides or motion-pictures should be essentially the same as a laboratory exercise in science. . . . In other words visual instruction should be reduced to a pedagogical method.

It will be seen by the above that whereas at present the ordinary educational film has only a limited usefulness in the schools in such subjects as nature study and geography, the more important problem of its value for normal school subjects by the production of a different type of film has yet to be solved. Many experiments are being made in the filming of well-known text-books and in the production of definite kinema text-books which may yield results of considerable value. Meanwhile, a very important original research is being carried out by distinguished experts in London, the report of which will soon be published and which will give much valuable information on some fundamental questions as to the relative value of the kinema and the lantern for teaching purposes.

There is, undoubtedly, in the kinema great educational possibilities, and the success of the important developments in visual instruction at the University of Wisconsin is a happy augury for the future.

Obituary.

ARTHUR BACOT.

ARTHUR BACOT, entomologist to the Lister Institute, died of typhus on April 12 at Cairo, where he was engaged in investigating the etiology of this disease and the precise method of its transmission through the agency of lice. His colleague Dr. Arkwright, working in the same laboratory, contracted the disease a few days later. His condition was the cause of grave anxiety, but he is now fortunately making a good recovery.

How they became infected is uncertain. They were occupied in experiments with lice that they had fed upon cases of typhus some time previously and had confirmed Nicolle's statement, hitherto unsupported, that the excreta of infected lice were capable of conveying the disease. Possibly they acquired the infection from such material. Experimental work upon typhus has already proved very costly, and Bacot's name is now added to the list of distinguished students, Conneff, Cornet, Jochmann, Luthje, v. Prowazek, Ricketts, Schussler, each of whom has fallen a victim to typhus while endeavouring to solve the problems of its etiology and epidemiology.

Bacot was born in 1866 and educated at Birkbeck

School. He did not enjoy the privilege of a scientific education, and on leaving school he became a clerk in a commercial house in the City, where he remained until forty-five years of age. Notwithstanding, his was a finely-trained scientific mind. Perhaps he was to the manner born. From boyhood he had been an enthusiastic entomologist, and despite his scanty leisure he became a lepidopterist of repute. Bacot was, however, no mere collector. Nor was he satisfied with observations and description of structure. It was the life history and bionomics of insects which attracted him and the use that could be made of entomology in the wider problems of heredity. He had an extraordinary knowledge of insects and a wonderful sympathy with them. Unfortunately his literary powers were slight, but his conversation on the subject of insect life was as fascinating as any of the writings of Fabre.

In the breeding of insects Bacot was extraordinarily successful, and some of the most important of his earlier contributions to entomological science were undertaken as studies in the laws of inheritance. Notable amongst these, which are scattered through the pages of the *Entomological Review* and the Proceedings of the Entomological Society, is his work with Prout "on the effects of cross breeding of different races of the moth *Acidalia virgularia*," which appeared in the Proceedings of the Royal Society, 1909.

The opportunity for Bacot to devote the whole of his energies to scientific work arose in the following way. The Commission for the study of plague in India having arrived at the conclusion that the essential means of spread of bubonic plague was the rat-flea, it was obviously advisable to obtain as much knowledge of the bionomics of these insects as possible. Bacot was invited to undertake the investigation. He was still occupied in clerical work, and at first he demurred on the score of both lack of time and lack of any special knowledge of fleas. His modesty was, however, overcome by the assurance that innocence of all but the external features of the siphonoptera was fairly general and the difficulty due to want of leisure was, to some extent, met by the provision of an assistant to carry out his instructions while he himself was at his office.

The results of eighteen months' work was highly satisfactory. The whole life history of the commoner rat-fleas was ascertained with great completeness, and the influence of all the significant environmental conditions upon their longevity and rate of propagation. The adverse effects of various treatments which might conceivably be used in combating plague were also determined. The observations formed the subject matter of a monograph on the bionomics of the common rat-fleas occupying 200 pages of the *Journal of Hygiene*. The work is a model of accuracy, clarity, and completeness, and at once stamped Bacot as an observer and experimenter of high quality.

The value of such a man to medical discovery was apparent, and in 1911 a special position was created for him at the Lister Institute, and he was invited to become its entomologist. He accepted the position, and henceforth was able to devote himself entirely to science and to apply his entomological knowledge and experimental skill to problems in epidemiology.

In the congenial atmosphere of the Institute, with well-equipped laboratories at his command, Bacot rapidly became expert with bacteriological and histological techniques, and was able to collaborate with his medical colleagues with completeness and to take a full share in the experimental work and in the responsibility for the results.

The Indian Commission had demonstrated fully that the agent of infection in the case of bubonic plague is the rat-flea, but the *modus operandi* it had been unable to determine. It was some years later (1913) that Bacot and Martin showed experimentally exactly how it occurred. From their observations, the very existence of plague seems to depend upon the accidental property of the plague bacilli of growing in the form of a coherent sticky mass. When the flea inflates its stomach with the blood of a plague-stricken rat, the bacilli, introduced with the blood, rapidly multiply in the alimentary canal, forming masses of culture. These masses increase quickly in size until they effectually plug the gizzard at the entrance to the stomach and grow forward in the gullet. A flea with its alimentary canal obstructed by this means suffers from a thirst which it is unable to quench, and bites with more persistence and much greater repetition than normally. The entrance into the stomach being obstructed, the efforts of the insect only inflate its œsophagus with the fresh blood, some of which runs back into the wound well dosed with plague bacilli, as soon as the action of the insect's pharyngeal pump ceases. What remains serves as culture media for plague bacilli to grow upon, and the result is, as Bacot was able to demonstrate by some wonderful sections, a flea contaminated, literally, up to its mouth. The plague bacillus passes no essential part of its life history in the body of the insect, such as is the case with the malaria parasite. It is an instance of spurious metaxeny, but a flea in the condition just described cannot fail to carry infection once it is let loose upon a susceptible animal.

In 1914 Bacot proceeded to Sierre Leone as the entomological member of a Yellow Fever Commission sent out by the Colonial Office. The original scheme of work was upset by the removal of the medical members owing to the war. Bacot, however, remained for one year and studied the bionomics of *Stegomyia fasciata*, the mosquito which is the transmitter of yellow fever, and produced a very complete and detailed monograph upon the life history of this insect in West Africa and the various conditions which modify its rate of propagation.

Bacot returned to England in August 1915 and at once threw himself into the intensive study of lice and the most practical method of ridding our soldiers of these vermin in view of their depredations and the incident dangers to health therefrom. The value of Bacot's work in this direction was great, and the experiments on which his conclusions were based were always made upon himself under conditions similar to those actually encountered in the field. The recommendations were soon found to be sound and practicable ones, and in 1916 he was asked to accept the position of honorary entomological adviser to the War Office. In this capacity he was constantly consulted by military sanitarians, who were bombarded with various nostrums and devices for dealing with the louse problem.

In 1915–16 our troops in France were found to be suffering from a new disease, "trench-fever," which soon proved to be a principal cause of medical invaliding.

McNee demonstrated that it could be transmitted from man to man by the inoculation of a small quantity of blood, and suggested that the usual manner of spread was by the agency of the innumerable lice infesting our soldiers. In 1917 a committee to study this new disease was appointed by the War Office with Sir David Bruce as chairman, and Bacot was invited to join as entomological member. The British Trench Fever Committee showed first that McNee's suggestion was correct and that this disease was transmitted by lice, a fact subsequently confirmed by the American Commission in France. In the course of their experiments Arkwright and Bacot confirmed the observation of Töpfer that minute pleomorphic bodies, of the order of magnitude 0·3 to 0·5 μ and somewhat similar to *Rickettsia prowazeki*, supposed by Rocha Limas and others to be the cause of typhus, were present in the gut of lice which had been fed upon patients suffering from trench fever. They failed to find them in lice with an unexceptional family history, brought up for generations by Bacot and nourished upon his own blood. Bacot studied the development of the little microbes in the gut of the louse day by day after its meal of infective blood, and he and his colleagues established that only lice in which these bodies were present were capable of transmitting trench fever. All attempts to cultivate the organisms have so far failed and the supposed causality of trench fever rests upon these observations of association.

Similar structures had been described by Ricketts and Wilder in 1910 in the gut of lice fed upon typhus fever cases, and later by Wolbach in the tissues of patients who had fallen victims to this disease. There was thus reason for supposing that the virus of both trench fever and typhus was of the same nature, and consisted of a new type of microbe which propagated in the tissue of the gut of lice and in the human body should it find access thereto.

Accordingly, when trench fever disappeared from this country, on the cessation of war, leaving many problems concerning it unsolved, Bacot turned his attention to typhus, as this disease presented analogies both as regards etiology and method of transmission. In 1920 he joined the Typhus Research Commission of the League of the Red Cross Society and went to Poland, taking with him a supply of his lice with a clean family history. He was responsible for the insect side of the investigation which, in view of the nature of the problem, was not the least important. The Commission, which has recently published its report, made many valuable observations. It was able to confirm under more rigid conditions of experimentation, earlier work which had been carried out in various parts of the world. The probability that *Rickettsia prowazeki* is the virus of typhus was thereby materially increased, but the labours of the Commission left the evidence resting upon association only.

In the course of work at Warsaw, Bacot accidentally infected himself with trench fever. Being in want of a further supply of lice for his experiments, he collected them from a public bath-house and nourished them upon his person. A sharp attack of the fever followed, and some of the insects were found to harbour the Rickettsia he and Arkwright had described in their work for the Trench Fever Committee two years previously. Afterwards, for some months, he was able to infect his clean stock of lice by feeding them on himself. Returning to London in the summer of 1920, with the collaboration of his colleagues Arkwright and Atkin, Bacot continued his endeavours to settle the matter of the virus of typhus. They were unfavourably situated in London to obtain a supply of typhus material. Consequently, when towards the end of last year an invitation came from the Egyptian Government to study the problem in Cairo, where typhus is endemic, the opportunity was welcomed. In company with Arkwright he proceeded to Egypt early in the year, and was soon installed in the excellent laboratories of the Department of Public Health, presided over by an old colleague, Dr. Charles Todd. The research was advancing with promise and his letters expressed enthusiasm regarding its progress. On March 24 he became ill and died on April 12.

Bacot had a passion for knowledge and a natural aptitude for scientific research. If the attainment of his quest promised to be of service to his fellow-creatures, this was an added attraction. He was well acquainted with the risks attending some of his work but, whilst never reckless, he was not a man to be deterred by danger from the pursuit of a useful inquiry. Its existence indeed appealed to a side of his nature which contributed to the charm of his personality.

His comrades at the Institute are proud of his attainments, but will rather remember him as a dear friend who was always helpful and was never known to be inconsiderate or unkind.

C. J. M.

LOUIS RANVIER.

IT must come as a surprise to many of the younger generation of biologists that Ranvier, whose name is immortalised in countless text-books, has but recently passed away. Born at Lyons in 1835, Louis Ranvier was attracted at the outset of his medical career to the study of histology, both normal and pathological. As concerns the minute investigation of the tissues, research and discovery were to all intents and purposes stagnant in France when the youthful Ranvier, full of indomitable zeal and unquenchable enthusiasm, devoted himself to the subject and determined that a study, the foundation stones of which had been laid by the great Frenchman, Bichat, should be worthily pursued. His early work was carried out in a small private laboratory which he equipped in the Rue Christine in Paris, where he and his friend Cornil not only taught the principles of histology to students but also produced, as a result of their joint efforts, the "Traité d'anatomie pathologique," a treatise which rapidly became classical.

Ranvier soon attracted the notice of Claude Bernard, who, recognising his great technical skill, enlisted his services for the College of France in 1867. He was soon put in full charge of a newly instituted Laboratory of Histology, where his reputation and fame grew so rapidly that a chair of general anatomy was created for him, into which he was installed in 1876. For a period of thirty years he was associated with the College of France, where he laboured with untiring zeal and where his most important discoveries were made.

The field covered by Ranvier's researches is exceedingly wide. There is no tissue and scarcely an organ of the body which he did not investigate with characteristic thoroughness. Much of what is to-day sound knowledge of the structure of the connective tissues, glands, nerves, and nerve-endings, we owe to Ranvier. His discoveries in connection with the peripheral nervous system are perhaps the most familiar. It seems incredible that until Ranvier taught otherwise, a medullated nerve was thought to be a continuous tube. The term "nodes of Ranvier," by which he is best known, is most unfortunate. He described the interruptions in the contour of the medullated nerve as "étranglements annulaires." The term "node" is inexcusable and not to be condoned by its usage as an alternative in "constrictions or nodes of Ranvier," a solecism of which many writers are guilty.

Ranvier was not content with describing and delineating the minute structure of tissue or organ but ever sought to discover the functional interpretation of what he saw. Many of his investigations were to this end, and in this sense he must be regarded as the father of experimental histology. A master of technique, his manipulative dexterity was unequalled, and the laboratory practice of the present day is largely founded on his methods.

Ranvier's numerous writings are a model of clearness and exactitude. Never content with knowledge at second hand, he took such meticulous care to ensure accuracy that his statements are invariably trustworthy. His "Traité technique d'histologie" is undoubtedly the most original text-book on the subject ever written, and bears monumental testimony to his indefatigable energy and boundless resource.

Some twenty years ago Ranvier retired from a life of incessant labour to his country estate. Laboratory and scientific societies knew him no more; as he worked so he rested, revelling in the pleasures of a rustic life. Full of years and honour Ranvier passed peacefully away on March 22.

Current Topics and Events.

MUCH interest has been aroused by reports in the *Times* and other newspapers of the discovery of mummified animals in the Koster caves, 100 miles west of Johannesburg, South Africa. These caves are situated in a district in which numerous stone implements and other evidence of early human occupation have been found. They have therefore been carefully examined by Mr. Harold S. Harger, a well-known geologist, whose report is disappointing. It appears that the mummified remains occur in a thick layer of bat guano on the floor of the main cave, and represent only modern animals. It is not unusual to find such remains in the circumstances described, and there is one known case in Patagonia in which the skin and soft parts even of an extinct animal (a ground sloth) have been preserved. There is no doubt that the caves and surface deposits in the Koster district of South Africa are well worthy of the attention of the local geologists and anthropologists, but they have not hitherto afforded anything of special note.

A LARGELY attended meeting of physicians and others interested in mental hygiene was held in the rooms of the Royal Society of Medicine on Thursday, May 4, in order to inaugurate the new National Council for Mental Hygiene. The chair was taken by Sir Courtauld Thomson, who was afterwards elected first president of the Council. He communicated to the meeting a message of welcome from the National Council of Mental Hygiene of the United States, and expressed a hope that, by the establishment of the British Council, Great Britain would be able to take her proper place in the forthcoming international conference on the subject. He made a special appeal to laymen to join the new movement, so that they might co-operate with the medical profession in a common endeavour to improve the mental health of the country. Dr. Head insisted that mental hygiene is as important as sanitation, that mind and body are inextricably intermingled, and that no structural disease is free from mental change. We should have been spared, he believed, the recent exhibition of auto-suggestion in this country, if its people had been better educated in mental hygiene. Sir Leslie Scott alluded to the greater assistance needed by those administering criminal justice from experts in mental disorders. Other speakers included Sir Humphry Rolleston, Sir Frederick Mott, Dr. Farquhar Buzzard, Lord Southborough, Hon. Lady Darwin, Major-General Sir John Goodwin, and Sir Maurice Craig. The provisional committee was empowered to draw up a constitution and to elect an executive committee.

THE half-yearly council meeting of the National Union of Scientific Workers was held on Saturday, May 6, at the Caxton Hall, Westminster, Dr. A. A. Griffith, president, in the chair. The report of the executive committee was presented by its chairman, Prof. L. Bairstow, who mentioned the co-operation of the Union with the British Medical Association in regard to removing disabilities suffered by scientific institutions under the Key Industries Act, and with the Teachers' Registration Council on the subject of the danger of parsimony in education. Progress in the negotiations with the British Association of Chemists was reported, and a scheme outlined which it was hoped might be made the basis of an immediate temporary arrangement for joint working, to tide over the period until complete amalgamation could take place. Negotiations on behalf of members had been carried on with the Ministry of Agriculture, the Air Ministry, and the India Office, and satisfaction obtained on many points. The Union had also been in communication with the Inland Revenue Commissioners for the purpose of furnishing them with a typical schedule of expenses incurred by scientific workers in various branches of science with a view of obtaining definite rulings and further concessions. Report was made of the successful working of the Government Section committee, which had enabled members in the various departments to discuss their common problems and formulate a common policy, and resolutions were adopted calling for the formation of similar sections to represent members engaged in university and other educational work, and members in industry. The vacancy on the executive caused by the death of Dr. Lyster Jameson was filled by the election of Dr. J. Henderson Smith, of Rothamsted.

THE *Quest* with the Shackleton-Rowett expedition has arrived at South Georgia after a cruise in the Weddell Sea. Mr. F. Wild, who succeeded Sir E. H. Shackleton in command, gives a summary of the results of the voyage in the *Times* of May 5. As was anticipated, ice conditions in the Weddell Sea proved to be unfavourable this year. After leaving the South Sandwich group where Zavodoski Island, the most northerly point of the Traversey Islands, was explored and surveyed, a course was set eastward. The pack was entered on February 4 in lat. 65° 18′ S., long. 15° 23′ E. Two attempts to penetrate southward failed on account of heavy ice and the low power of the *Quest*. The positions reached were respectively lat. 69° 18′ S., long. 17° 11′ 30″ E., and lat. 69° 49′ S., long. 0° 1′ W., and mark approximately the points where Bellingshausen in 1820 was forced to turn back when seeking a route to the south. No new land was discovered by the *Quest* although the soundings indicated, as was expected, that it could not be far south of lat. 69° S. After the second failure to get south, the *Quest* turned westward across the Weddell Sea through heavy pack. The objective was Ross's "appearance of land" approximately in lat. 65° S., long. 44° W. This report, which dates from 1843, had never been actually disproved although subsequent expeditions to the Weddell Sea had made the existence of land in that locality extremely unlikely. The *Quest* was beset within 35 miles of Ross's "appearance of land," and escaped only with difficulty. There was no sign of land and the depth of the sea was 2446 fathoms. The *Quest* then sailed for Elephant Island and South Georgia. On April 18 the expedition was to leave for Tristan da Cunha, Gough Island, and Cape Town. The expedition has not succeeded in adding to our knowledge of Antarctic lands, but has done valuable oceanographical work. A line of soundings between South Georgia and the place where the pack was entered cuts across a practically unsounded region. The track across the Weddell Sea seems to follow the course of the *Scotia's* line of soundings in 1903.

IN the *Chemiker Zeitung* of April 15 it is announced that Prof. P. P. von Weimarn has been appointed Research Associate of the Imperial Research Institute of Osaka, Japan, and charged with the creation of a laboratory for research in colloids.

NOTICE is given by the Chemical Society that applications for grants from the Chemical Society Research Fund must be received, on the forms provided, on or before Thursday, June 1.

ON Tuesday next, May 16, Prof. W. Bulloch will begin a course of two lectures at the Royal Institution on "Tyndall's Biological Researches" and "The Foundations of Bacteriology." These are the Tyndall Lectures. The Friday evening discourse on May 19 will be delivered by Sir William Bragg on "The Structure of Organic Crystals."

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry, Salters' Hall, St. Swithin's Lane, E.C.4, for a limited number of fellowships, each of the annual value of 250*l*., falling vacant in October next. Applications, with full particulars of training and experience, must reach the Director of the Institute before June 10.

THE Board of Trade has received formal notices of complaint that boric acid and metaldehyde have been improperly included in the lists of articles chargeable with duty under Part I. of the Safeguarding of Industries Act, and that gallic acid and "R" tannic acid have been improperly excluded from these lists. These complaints will be submitted to the Referee, and persons directly interested should communicate with the Assistant Secretary, Board of Trade (Industries and Manufactures Department), Great George Street, London, S.W.1.

THE list of papers bearing upon the zoology, botany, and prehistoric archæology of the British Isles, issued during 1920, which has been prepared by Mr. T. Sheppard and published in the Report of the British Association for 1921, is now available as a separate pamphlet. The list occupies fifty pages of close print and is divided into three sections, zoology, botany, and prehistoric archæology. In this form it should prove very useful to students and workers. The list of papers is very complete, and as a guide to the work done in the British Isles it will be invaluable to workers in systematic natural history and to those responsible for regional surveys. Copies may be obtained, we understand, at the offices of the British Association.

THE Zoological Society has acquired by purchase two reindeer from Norway for its collection. During March 157 additions to the menagerie were received, 61 by presentation, 20 deposited, 70 by purchase, 2 by exchange, and 4 born in the gardens. The most interesting of the new acquisitions are two tree porcupines from Canada, three Alpine marmots from southern France, and a black-gloved wallaby from W. Australia. An Indian kestrel from Darjeeling is new to the Society's collection. At the monthly meeting of the Society on April 19, thirty-five new fellows were elected and forty candidates proposed for membership.

THE celebration of the centenary of the Royal Astronomical Society will begin on the evening of Monday, May 29, with a Conversazione, to be held, by kind permission of the Royal Society, in their rooms, at Burlington House. The following morning will be devoted to an introductory address by the president, Prof. A. S. Eddington, one on the history of the society by Dr. Dreyer, and a biographical address, with portrait slides, by Prof. Turner. In the afternoon there will be a scientific meeting, at which associates of the society present will be invited to speak on their work. A dinner will be held in the evening. On Wednesday, May 31, fellows and associates have been invited by the president and council of the British Astronomical Association to attend the meeting of the association, at Sion College, Victoria Embankment, and on Saturday, June 3, there will be a visit to Greenwich Observatory, by invitation of the Astronomer Royal.

EARL BUXTON'S comments, at the annual meeting of the Royal Society for the Protection of Birds, on the ways and methods of the modern egg-collector, have made something like a sensation in the ornithological world, focussing and expressing, as they do, a feeling of protest strong among the majority of bird-students against the wholesale and reckless collection of wild birds' eggs in clutches by certain "oologists." The text of that part of Lord Buxton's speech is published in the spring number of *Bird Notes and News*, from which it appears that for the purpose of so-called science the successive layings of certain birds for an entire season are sought in various parts of the country, by the collector and his agents, regardless of the comparative rarity of the species, and also, it would appear, of Bird Protection Orders. Lord Buxton's subsequent correspondence with representatives of the British Ornithologists' Union will appear in the Society's annual report. The pages of *Bird Notes and News* are doubled in number with the present issue, the first of its tenth volume and twenty-first year.

THE Bulletin of the South-Eastern Union of Scientific Societies announces that the twenty-seventh Annual Congress of the union will be held at Southampton, on June 14-17, inclusive. The new president, to be elected at the evening meeting of the first day, is Col. Sir C. F. Close, who will give an address on "Small Rivers as Sources of Power: with special reference to the River Itchen." Archæology, botany, geology, and physiology will be represented in the papers and lectures which will be delivered at the Congress, and the programme which has been prepared should prove a very comprehensive and interesting one. At a recent council meeting an Archæological Section of the union was authorised, and Sir Edward Brabrook, Dr. W. Martin, and Mr. H. Norman Gray were appointed to deal with its development, with power to act. The council has also authorised the formation of a Zoological Section, and the carrying out of the initial steps have been entrusted to Prof. E. B. Poulton, and Messrs. R. Adkin, H. J. Turner, and Stanley Edwards.

THE next International Conference of Pure and Applied Chemistry will be held at Lyons on June 27-July 2, and as usual a variety of topics of interest to chemists will come up for discussion. The former International Committee on Atomic Weights has now, in consequence of the recent work on isotopes, become an International Committee on the Elements, and the British representatives are Prof. Soddy and Dr. Aston; another committee is considering a uniform system of abbreviations and a third is dealing with the preparation of research chemicals. The Federal Council for Pure and Applied Chemistry has asked Mr. F. H. Carr to act as correspondent for this committee. Mr. A. Chaston Chapman is acting as correspondent, in conjunction with the Society of Public Analysts, in connection with a project for the standardisation of food analysis, and Dr. Mellor has been appointed to put forward the views of British chemists in relation to ceramic matters. Most countries which are represented at these conferences have a fund from which the expenses of the delegates can be paid. Great Britain is an exception, and the Chemical Society has in a very public-spirited manner agreed to pay the travelling expenses of two of the delegates from this country. Some other bodies should follow this excellent example in order that Great Britain may take an adequate part in the regulation of those chemical matters which are capable of international treatment. To meet together in foreign parts, making the acquaintance of chemists from divers countries and comparing notes, helps to advance knowledge. *Plurimi pertransibunt et augebitur scientia*, as the Vulgate puts it.

Our Astronomical Column.

THE PLANET MERCURY.—Mr. W. F. Denning writes that the most favourable time of the present year for viewing this object will occur between May 12 and 27. Mercury is rarely visible to the naked eye, and intending observers should utilise the present opportunity of catching a glimpse of the fugitive little object, which it is recorded always evaded the eyes of Copernicus. The planet will be at its greatest apparent distance from the sun on May 23 and will set about two hours after the sun for about a fortnight. It will be easily visible to the naked eye near the west-north-west horizon, at about 8.40 P.M. G.M.T. if the sky is clear in that region. Twilight will be very strong but Mercury may be seen with a rosy fluctuating light rather brighter than that of a first magnitude star. It may be easily identified, for the bright planet Venus will be not more than four or five degrees to the eastward, and situated to the left and above the smaller orb of Mercury.

ADVANCES IN ASTRONOMY.—The presidential address to Section A at the Durban meeting (1921) of the South African Association for the Advancement of Science contains a good *résumé* of the remarkable advances in stellar astronomy during the last half-century. The treatment is full and explicit, and includes Dr. Shapley's investigations on the globular clusters (not, however, the recent criticisms of his conclusions) and the remarkable results obtained with the Mt. Wilson interferometer, both in investigating close binaries, such as Capella, and in measuring the angular diameter of the giant red and orange stars.

Many personal details of the donors and the designers of the great American telescopes are given; as a contrast Airy is quoted as saying in 1832 that no public observatory existed in the United States. The address concludes by expressing the hope that the development of university education in South Africa will lead to a corresponding expansion of astronomical observation and discussion, and the conviction that such studies draw out all that is highest and best in the human intellect.

Research Items.

MEXICAN ARCHÆOLOGY.—Since the days of the Spanish occupation, the neighbourhood of Mexico City has supplied a rich field for the exploration of the antiquities of the pre-Columbian period. The most important problem to be solved is the investigation of the strata showing the succession of cultures —the Archaic, Toltec, that is pre-Aztec or Teotihuacan, and Aztec. Some progress in this direction is outlined in a report by Mr. A. M. Tozzer, published in Bulletin 74 of the Bureau of American Ethnology. It is at present impossible to determine with exactness the demarcation between the Toltec and Aztec cultures, the inference being that the former flourished towards the end of the first millenium A.D., and their influence in Yucatan, at least, extended into the fifteenth century. The artifacts discovered belong principally to the Toltec culture, those of the Aztec period being few in number and relatively unimportant, while a few things which are clearly pre-Toltec or Archaic were encountered. It is interesting to record that the methods of scientific archæology are being applied to this area, with expectations of important discoveries in the near future.

FOSSIL MAN.—The Trustees of the British Museum have just issued a third edition of the useful little "Guide to the Fossil Remains of Man in the Department of Geology and Palæontology in the British Museum (Natural History)." The guide was first prepared on account of the interest in the study of fossil man which had been aroused by the discovery of the Piltdown Skull, and, as an introduction to the specimens and casts exhibited, described the main conclusions bearing on the question of the evolution of man which are furnished by palæontology, geology, and anthropology. In the third edition, the later part of the guide has been rewritten and extended to include an account of the skull found in the Broken Hill Mine, Rhodesia, in 1921, and two plates giving four aspects of the skull have been added. The more remarkable features of the skull are briefly described, and the chief points in which it presents similarities to the anthropoids, Neanderthal man, and modern man are noted. As regards the question of antiquity, it is pointed out that the life of the southern hemisphere has been less progressive than that of the northern, and the discovery of primitive species of man in comparatively modern deposits was to be expected. After summarising the evidence it is concluded that either the accumulation of animal remains in the cave is modern compared with deposits left by palæolithic cave men of Europe, or the animal life of Rhodesia has changed more slowly than that of Europe.

GEOLOGY IN NEW ZEALAND.—Prof. J. Park reviews the structure of New Zealand in the Transactions of the N.Z. Institute, vol. liii., 1921, a publication that includes several papers on geology. As seems usual in that enterprising and fortunate dominion, the illustrations are of very fine quality. Brother Fergus (M. J. Gilbert) describes the unconformable series of the Waikato Heads district, where an "older-mass" terminating in the post-Jurassic peneplain is capped by a "younger-mass" of undetermined Cainozoic age. Mr. J. A. Bartrum revises the geology of Great Barrier Island, which guards the Hauraki Gulf on the long promontory of the North Island; he has discovered a large area of delicately banded Cainozoic rhyolites, previously described as slates and sinter. Dr. C. A. Cotton's account of the warped land-surface near Port Nicholson, the harbour of Wellington, is written with a true geographic instinct.

THE GALICIAN PETROLEUM INDUSTRY.—On April 11, a paper on "Galicia and its Petroleum Industry," by Mr. Albert Millar, was read at the Institute of Petroleum Technologists, in which was embodied technical and economic information of interest and importance. The most important area at the present time is still that of Boryslaw-Tustanowice-Mraznica, this being the district of the largest producing wells during the last fifteen years. As is well known, however, there has been a steady decline in production latterly, both in this area and in Galicia as a whole. While this causes alarm in certain quarters, it has been the means of promoting the development of new fields, chiefly those of Hordyscze, Ratoczyn, and Opaka, in the Tustanowice district; deep drilling at Popiele and Jasienica, north-east of Boryslaw, has also been undertaken. The bulk of the oil, which is of high grade and has a paraffin base, has hitherto been obtained from Oligocene beds, together with a smaller quantity from Eocene deposits. The Cretaceous rocks, petroliferous in Western Galicia, are largely an unknown factor as regards their ultimate commercial value, as they have been penetrated only by a few wells in the main region, and the results were inconclusive. Many experts believe that water troubles will prove more formidable at the Cretaceous horizon than is the case in the younger sands. Unquestionably water is the greatest difficulty to contend with in Galicia, and the calamitous experiences at Tustanowice, where "200 ton" wells were rapidly watered, have done much to inspire misgiving as to future prospects. Emulsification up to, and in some cases more than, 20 per cent., has resulted in special methods being devised for separating the oil. Zuber believed this water to be the indication of exhaustion of the field, but later observers favour its localisation to Eocene sands. Gasoline extraction, started in 1914, has made much headway, 660,000 klg. being obtained last year, a record production for Galicia.

A NEW METHOD OF GAUGING THE DISCHARGE OF RIVERS.—The method of gauging discharge based on the principle underlying chemical hydrometry has been in use for some time. It depends on the liberation of a known quantity of salt in solution into the river at a known rate and the estimation of the amount of salt in the river some distance below the inlet of the salt solution. This method has been proved to give very accurate results, but its chief disadvantage is the cumbersome nature of the preparations involved, not to speak of the cost. In the Scientific Proceedings of the Royal Dublin Society for April, Prof. J. Joly describes a method of utilising the same principles which gives even more accurate results and is very economical in labour and money. Radioactive measurements can be made with great accuracy by a simple form of electroscope. In the place of salt, which has to be introduced into the river by the hundredweight, a few litres of a solution containing a trace of radium is sufficient. Prof. Joly proposes to use pitchblende dissolved in nitric acid and then diluted with water. The solution is fed into the river under constant pressure. The water samples when collected are conveyed back to the laboratory and stored in ordinary boiling flasks for ten or twelve days. The emanation is then boiled off into a small exhausted bulb, from which it is introduced into the electroscope. At the end of three hours the electroscope is read and the river discharge can then be deduced.

Science in Bohemia.

By PROF. BOHUSLAV BRAUNER, Bohemian (Charles') University, Prague.

THE years during the war and after were not very favourable to our scientific investigations. The grants for the scientific institutions were reduced by the late Austrian Government in the same degree as the prices of instruments, etc., increased; many a young man of science has left the High Schools and never returned again. We are now enjoying the fourth year of our liberty and independence, but our country was bled by Austria, so that in order to keep our liberty, which we owe to the magnanimous support (moral only, alas!) of the Allied Powers, our Republic had to start its life from the very beginning. Paper and printing became so

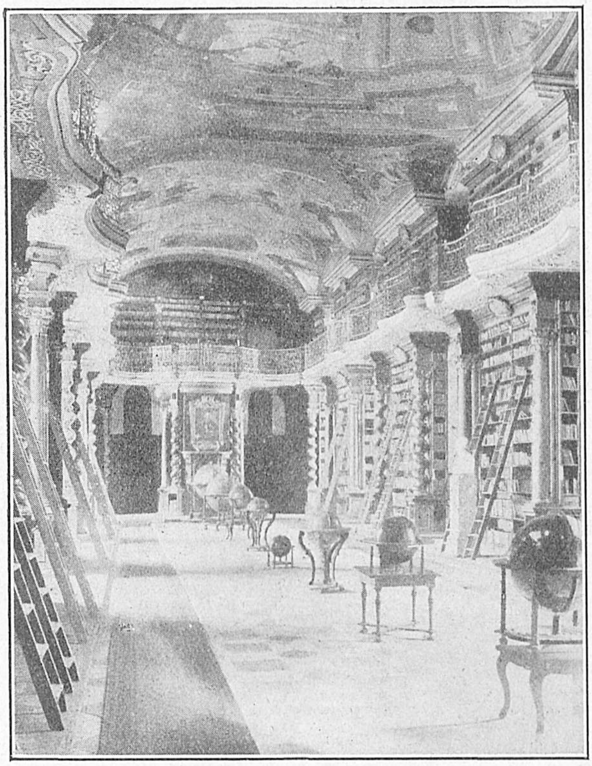

FIG. 1.—Central Hall of the old University Library, Clementinum, Prague.

enormously expensive that the two chief scientific societies, the Royal Society of Bohemia, founded in 1770, and the Bohemian Academy of Science and Art, founded 1890, are able to print only very short scientific communications.

I beg, therefore, to place before English men of science a very condensed account of the most prominent papers published during the last few years by Bohemian men of science. (Our German countrymen publish their scientific papers in Germany or in Vienna—as before the war.)

ASTRONOMY AND ASTROPHYSICS.—With the 8-inch telescope of the Observatory of the University no important work can be done. Prof. Brauner refers to a communication published in NATURE of April 8, 1909 (vol. 80, p. 158), entitled "The Gases of the Ring Nebula in Lyra," in which he showed that of the four gases, separated by rotation as visible from Th. Wolf's spectra, the innermost gas ($\lambda=460$) must be lighter than hydrogen, whereas the outermost gas D ($\lambda=373$) will have a density between that of hydrogen and helium. We know to-day that the densities of the gases hydrogen and helium in nebulæ are proportional to their atomic weights. The line $\lambda=469$ in the gas A is now generally regarded as a line in the principal series of helium and identical with the line $\lambda=4685{\cdot}90$ obtained by Fowler by condensed spark discharge, but other helium lines, especially $\lambda=5876$ (10), are missing, and so the gas is called "protohelium." That the line $\lambda=373$ or $\lambda=3726{\cdot}1$ and $\lambda=3728{\cdot}838$ really corresponds to a gas heavier than hydrogen and lighter than helium was proved by Bourget, Fabry and Buisson, who found in 1914 that its density is 2·74, whereas Nicholson calculates 2·95.

METEOROLOGY.—After the Austro-Hungarian Empire went to pieces it became the duty of the young Czechoslovak Republic to establish an institute that would take charge in its territory of the stations that were previously under the agency of the Vienna and Budapest central meteorological offices. At the beginning of 1920 the Board of Education established the State Meteorological Institute (Prague II. U Karlova 3.), the first duty of which was to re-examine the list of the stations that suffered badly during the war. The central office is now running 120 stations, of which four are first-class observatories, Prague, Milešovka (mountain station, elevation 2550 feet), Brno and Stará Ďala. To the central office more than 20 stations send their observations daily, and a report of these is dispatched by "radio" three times daily from Prague. Monthly reviews of the weather are published meanwhile for the whole Republic and the climatography of the country is being prepared. The credit for this important work is due to Prof. Hanzlík and Director Schneider.

PHYSICS.—This science does not possess any long tradition in Bohemia, for the first really modern physical institute was built by Prof. Strouhal—who is known for his work "On Steel" carried out with Prof. Barus forty years ago—only in the first decade of this century. His successor was Prof. Bohumil Kučera, whose early death in 1921 is lamented. His principal work was on radioactivity. This highly talented physicist, a good English scholar, was preparing a text-book on mechanics for English students. Prof. Posejpal is working chiefly on the dependence of the refraction of gases on their pressure. Prof. Macků, one of our best physicists, is studying the oscillation of 2 and 3 conjugated circles. Another promising young physicist is Prof. Žáček, who investigated the influence of the spark on the oscillation frequency and deduced a general formula for it. He has also done important work in radiotelegraphy. The professor of natural philosophy (theoretical physics), Záviška, has studied the theory of electromagnetic waves, especially their flexion on parallel ring-cylinders.

INORGANIC CHEMISTRY.—The war was very unfavourable to chemical investigations: coal was sent to Germany and we were freezing in our laboratories and lecture rooms. There was no gas-supply during the daytime, platinum, accumulators, copper apparatus, etc., were confiscated by the late Austrian

Government, and no foreign periodicals (except German) were admitted. Inorganic chemistry had no tradition until 1877, when Brauner showed the aims of modern inorganic chemistry: chemical (and later physico-chemical) investigations of elements with regard to their position in Mendelejew's Periodic System. A series of results obtained was published in the Trans. Chem. Soc. Lond. since 1881. During the war Brauner published a revision of the atomic weight of praseodymium which yielded the number Pr = 140·94 with a material separated from cerium and lanthanum for the first time by direct methods (not fractionation). The value obtained agrees exceedingly well with that obtained by Baxter and Stewart in 1915, who found Pr = 140·924, but were unable to remove cerium and lanthanum entirely.

A revision of the atomic weight of tin carried out by Brauner and Křepelka, and later on by Křepelka alone, gave the value Sn = 118·699, agreeing exactly with that obtained by other authors. In conjunction with Th. W. Richards, Křepelka determined the atomic weight of Al = 26·963 based on the analysis of the bromide, $AlBr_3$; this revision carried out at Harvard University is being continued in Prague on the chloride, $AlCl_3$.

Scandium was prepared by Prof. Štěrba-Böhm in a state of "spectral" purity (Hönigschmid found with this material Sc = 45·10).

The close analogy between boric and aluminic acid has been shown by Dr. J. Heyrovský, who made a physico-chemical examination of solutions obtained by dissolving (amalgamated) aluminium in aqueous solutions of the hydroxides of the alkalies, alkaline earths, and of ammonium. He ascertained that the process in all cases is additive, consisting in the formation of a complex anion $Al(OH)_4{}^1$, provided that the cation is strongly positive. He also determined the basicity and acidity of aluminium hydroxide and its bearing on the electrolytic potential of aluminium. Aluminium must be regarded as the true "Ekaboron"; in the constitution of the above compounds, apparently pentavalent, it is really positively trivalent aluminium (4 + and 1 − = 3 +), as was explained by Brauner in his preface to a text-book of analytical chemistry.

ORGANIC CHEMISTRY.—Prof. Votoček, of the Bohemian Polytechnic High School, is continuing his well-known work on sugars and has analysed with Burda the sugar components of lichens.

ANALYTICAL CHEMISTRY.—Prof. Štěrba-Böhm and Vostřebal worked out an exact method for the quantitative determination of molybdenum as trisulphide, using an admixture of formic acid on account of its high dielectric constant.

For the analysis of minerals the result of Štěrba-Böhm and Rosický's investigation of the new mineral "ultrabasite," from Freiburg in Saxony, is important; "basic" sulphides of silver and lead preponderate over the "acid" sulphides of tin and germanium. It contains 2·2 per cent. of germanium; thus ultrabasite becomes the fourth known germanium-containing mineral.

ZOOLOGY.—Our most prominent investigator in this branch of science is Prof. František Vejdovský, of the Bohemian University, who finished during the war his life-work, "The Structure and Development of the Living Substance" (in English). This work contains many coloured drawings (illustrations), but owing to the want of the necessary means the author was hitherto unable to publish it.

Vejdovský's successor, Prof. Mrázek, is very active in the zoological investigation of Bohemia with special regard to the ecology of the lower animals in ponds and lakes.

SYSTEMATIC BOTANY.—Prof. Josef Velenovský, the chief of our school of systematic botany, who is well known for his leading work "Flora Bulgarica," has just published another great work, "Bohemian Mushrooms," 4 vols. 920 pp., Prague, 1920–1922, which is richly illustrated. In order to study all kinds of fungi growing in Bohemia, he lived for a series of summers in the chief big forests of our country. He finds, *inter alia*, that far more mushrooms are edible than is generally accepted, but there are some which are poisonous or edible according to the weather and season. From his institute a series of papers was published by Domin, Kavina, Schuster, Daněk, containing interesting morphologic, cytologic, etiologic, and phytogeographic studies.

Prof. Domin, also of Bohemian University, continues his plant geographical investigations, especially with regard to Australian plants and also the Alpine flora of the Tatra Mountains.

PLANT-PHYSIOLOGY.—In this department excellent modern work has been done by Prof. Bohumil Němec, who has published two recent text-books: "Introduction into General Biology" and "Plant-anatomy and Plant-physiology." He has also published a series of papers on the Cecidia of the Eriophylages, on the infection of root-tubercles of Ornithopus, and on the influence of centrifugal force on plant cells. It is known that he was the first to explain geotropism. It should be mentioned that from his school O. Vodrážka proved the presence of a special statolithic starch in the blossoms and sheaths of positively geotropic plants with nyclinastic motions. J. Peklo isolated a symbiotic bacteria (azobacter) from the mycetocytus of the plant-louse *Schizoneura lanigera*. The work of Vl. Ulehla on the analysis of lateral and negative geotropism of Pharbitis and its *rôle* in the climbing character, and also that on heredity of A. Brožek, who succeeded in obtaining a mosaic bastard from two pure lines of Monulus, and studied the case of a simple Mendelian heredity in blossom-patterns, should also be mentioned. E. Senft has described the *rôle* of slime-trichoms in germination. The object of other work in this institute is the physico-chemical investigation of plant-life and also its connection with the chemistry of colloids.

GEOLOGY, PETROGRAPHY, AND MINERALOGY.—These three have the best traditions of all sciences in Bohemia, for they were cultivated by the most prominent men of science since about 1800. The conditions of publication during the war and after permit only of printing special papers of a very limited extent in the Transactions of the Bohemian Academy or of reviewing articles in journals with a broader programme.

Of the geological formations in the Bohemian countries the best known are those which Barrande united under the title "Système silurien," making them classical territory in his gigantic palæontological work, "S. S. du Centre de la Bohême." To-day, putting those formations together under the designation "Barrandien," on account of a tectonic common to them, we distinguish them into a succession from the Algonkian to the Devonian.

The research of Barrandien hitherto done was principally palæontological; for the solution of stratigraphic and tectonic questions a petrographic knowledge of eruptive and sedimentary rocks and the conditions of their origin was wanting. During the last few years this work has been organised and carried out by Dr. František Slavík, professor of mineralogy and petrography in our University, with his collaborators, for the lower horizons from the Algonkian to the Ordovician in their whole extent. Slavík and Prof. Kettner completed in a series of publications the older research of Slavík on the Algonkian; Kettner worked up in monographs the lowest Cambrian (layers of Žitec) and the lower siluric horizon of Krušná Hora from the point of view of the genesis of the sediments; Dr. Slavík, with Mrs. Dr. Slavík, has described the oolitic chamoisite ores, their sedimentary genesis and the circulation of phosphorus.

Numerous other papers on the Barrandien by Kettner, Kodym, Purkyně, now director of our State Geological Institute, and Prof. Woldřich, give detailed tectonic pictures of the single districts; Kettner and Kodym have proposed a change of Barrande's designation of the horizons which is in agreement with the recent results of their investigation.

Another formation which is extended over large areas in Bohemia and Moravia and richly divided is the Cretaceous formation. The detailed stratigraphy and facial change of this formation has been for more than thirty years the object of thorough studies by Čeněk Zahálka, who has published great monographs of the Cretaceous formation in Podřipsko, Středohoří and Eastern Bohemia, whereas the environments of Prague were in this direction investigated by his son, Břetislav Zahálka; special studies were made by Woldřich.

As regards the petrography and geology of plutonic eruptive rocks and crystalline schists, two territories were intensively studied within recent times: the Bohemian Forest and the granitic massive of Middle Bohemia.

The work of Sokol on the Bohemian Forest has yielded a basis for broader studies of the primary inhomogeneity of the magma.

The ore deposits were also intensely investigated, especially the gold-veins and beds of iron ores (Mrs. Dr. and Prof. Slavík, Kettner, Stočes).

In special mineralogy a series of crystallographic papers was published (Ježek on Johannite, Ondřej on the Bohemian quartzes, Rosický on the topaz and gypsum, Slavík on the lacroisite), and chemical papers (Splíchal on the products of decomposition of the felspars, Rosický and Štěrba-Böhm on the ultrabasite).

GEOGRAPHY.—During the war this science centred round the "Bohemian Geographical Society," which, in spite of the difficult conditions, was able to issue its transactions in the "Sborník." Owing to the Austrian censorship political geography was very limited and chiefly physical geography was cultivated. The fall of Austria means, of course, a new era for our political geography. Prof. Daneš's studies on the population of the industrial districts of Bohemia and Prof. Dvorský's on Yugoslavia as well as his book, with a political programme, on the territory of the Czechoslovak people, are the prominent works in this branch. A great work was started in ethnography with the first volume of the "Ethnography of the Czechoslovak People" (editor K. Chotek).

The chief geomorphological works based on geology and tectonics are: Prof. Daneš's on the "Kras" (Kars) of Australia and Java, Absolon's on the Moravian "Kras" (Kars), Dědina's on north-eastern and Sokol's on western Bohemia, and Vitásek's on the upper Odra district. An interesting monograph on Czechoslovak earthquakes has been written by Koláček. The military geographical State Institute, founded at the beginning of the Republic, published a series of fine maps of our new state, both charts of large areas as well as special maps, 1 : 25,000 and 1 : 75,000.

Wheat Prices and Rainfall in Western Europe.

IN an article on "Weather and Harvest Cycles" in the *Economic Journal* of December last Sir William Beveridge gave index-numbers showing the fluctuation of wheat prices in each year from 1500 to 1869, and made a preliminary mathematical and arithmetical analysis of these figures with a view of discovering periodicity in the yield of harvests, which might be attributed to periodicity in the weather. In a paper read to the Royal Statistical Society on April 25, he has now given the results of a much fuller analysis, involving a test of the same figures by harmonic analysis, for the discovery of practically all possible periods between 2 and 84 years' length. The following is a summary of the paper.

The amplitudes for more than 300 trial periods altogether have been calculated for a sequence of about 300 years from 1545 onwards, while for a number of these trial periods amplitudes have been calculated separately for the first 150 years and for the second 150 as well. These are shown on a periodogram from $q=150$ (2 years) to $q=3{\cdot}6$ (84 years). Each of the apparent periods indicated by the periodogram is considered in the light of four tests of periodicity: namely, the test of intensity (that is to say, comparison of the actual amplitude with the expectancy); the test of changing signs (both the elements a and b being required by theory to change signs in the neighbourhood of a period); the test of continuity (that is to say, indicating the same period, with agreement of phase as well as length, in each half of the sequence); and the test of agreement with other records (that is to say, the discovery of a similar periodicity in rainfall, temperature, or some other meteorological element). Particular importance is attached to the third of these—the test of continuity.

The results of this analysis are summarised in a table showing some 20 apparent periods ranging in length from 2·2 to 68 years. These are arranged in four groups:—

(1) Periods the reality and persistence of which is beyond doubt, strong evidence from the analysis of wheat prices being confirmed by close agreement of first-rate meteorological evidence. This group includes the period of 2·200 years discovered originally by Mr. C. E. P. Brooks, and later by Mr. J. Baxendell in rainfall; the period of 5·1 years discovered by Mr. J. Baxendell in wind and rainfall and by Capt. D. Brunt in Greenwich temperature; and the period of about 35 years discovered in 1890 by Dr. Brückner in temperature, rainfall, and barometric pressure.

(2) Periods strongly indicated by the wheat prices but for which meteorological confirmation is, at present, weaker or lacking. This group includes seven periods of 5·671, 9·750, 12·840, 15·225, 19·900, 54·000 and 68·000 years. Most of these periods are relatively long, a fact which helps in explaining failure

to demonstrate them hitherto in meteorological records. For most of them some meteorological parallel can in fact be found.

(3) Periods for which there is good, but not first-rate, evidence both in wheat prices and in meteorology. There are four of these with lengths of 3·415 years, 4·415 years (traced by Mr. Baxendell in rainfall), 5·960 years (traced by various writers in barometric pressure), and 8·050 years (no doubt the same as the period to which Prof. H. L. Moore and others have directed attention).

(4) The fourth group includes periods, some of which no doubt have reality, but all of which present inconstancy of action, changes of phase or other puzzling features. These include periods of 2·735, 5·423, 7·417, 12·050 and 17·400 years in addition to the well-known eleven-year period of the sunspots, which reappears in wheat prices with much of its normal instability of character.

The large number of periods found is striking. On *a priori* grounds, however, there is nothing really surprising in the suggestion of so many separate periodicities in the weather. Comparison between the weather cycles indicated by analysis of wheat prices from 1550 to 1850 and the actual rainfall in the ensuing 72 years, 1850 to 1921, confirms the view that these periodicities are real and important. For the purpose of this comparison, 11 of the 13 cycles in the first three groups are combined by a simple graphic method, the lengths and phases taken being exactly those determined by harmonic analysis; the combined result is shown in a single "synthetic curve" and is compared with the rainfall at 24 stations in Western and Central Europe (*i.e.* roughly the same area as that covered by the wheat prices records). A very high measure of agreement appears between the synthetic curve derived from wheat prices before 1850 and the rainfall as actually recorded after 1850.

In particular, the synthetic curve shows depressions foretelling lack of rain (which, in the area under review, is generally beneficial to wheat) at each of the markedly dry years in the past 70, namely 1857, 1864, 1870, 1874, 1883–4, 1887, 1898, 1904, 1908–9, 1921. It shows peaks foretelling heavy rain in the rainy years 1852, 1866, 1872, 1876 (for 1877), 1906, 1912, 1916. The only important discrepancies are the failure of the synthetic curve to show peaks for the rainy years, 1860 and 1903, and a depression for the somewhat local, though severe, drought of 1893. In other words, the synthetic curve which, subject to certain reservations, could have been drawn in 1850, if then drawn, would have foretold nearly all the important droughts and rainy seasons of the next 70 years. The drought of 1921 stands out quite remarkably well.

In view of the inevitable errors in the simple hypothesis upon which the synthetic curve has been constructed, the very large measure of agreement obtained in spite of these errors is all the more convincing as to the substantial correctness of the results of the analysis. The question whether definite periodicities in the weather exist and can be discovered, must now be answered in the affirmative.

The two most interesting questions of all must still be left unanswered. The first is, what will be the weather next year and in the following years. As to that no prophecy is made at all; rather, the opportunity is taken of definitely withdrawing anything which might have appeared like a prophecy in the earlier paper. The author is not prepared to say anything as to whether 1923 will be wet or dry. The full mathematical analysis in many ways has confirmed the earlier conclusions, but in more important ways goes beyond them; the general result might be quite different. Trustworthy prophecy of general weather conditions on the basis of periodicities now demonstrated should become possible in the near future, but only after a far more elaborate investigation than it has yet been possible to make.

The second question is, as to the seat and the physical cause of the periods appearing in the weather. A further analysis of the economic data may be helpful in some directions, but for the most part, that is a question for astronomers and physicists and should be left for them to answer.

The Teaching of Natural History in Schools.[1]

PROF. HICKSON and the other distinguished zoologists who have drafted the memorandum referred to below are deeply and properly concerned at the general neglect of zoology as a school subject. They maintain that this science should serve as a means of introducing youth to many of the greatest problems of life, and they therefore express astonishment, which will be shared by many people, at the findings of the investigators of the Secondary School Examinaton Council on the subject of school natural history. This body, in a recently issued report, committed itself to the remarks that "very few of the candidates (for certain important school examinations) offer this subject (Natural History), and it seems very doubtful whether it is worth while to maintain it as qualifying for a Pass with Credit in Science."

The members proceeded to express the opinion that the principles of biological science can be better illustrated by means of botany. From this latter view the authors of the memorandum dissent vigorously, and although the arguments they use will not perhaps appeal to botanists, there can, we think, be no doubt that all fair-minded botanists will support their conclusion that the principles of biology cannot be taught without reference to the animal kingdom.

More is wanted, however, than vigorous protest against examiners' opinions. Zoology is a science of vast range and school time is already taken up with many subjects. It devolves on the teachers of zoology to show in detail the kind of zoological syllabus that can be put into operation in schools as a basis for zoological teaching. In the drafting of such a syllabus they would naturally consult those teachers who have succeeded in maintaining and popularising zoology in their schools. As a preliminary to such a useful piece of work it would be necessary for zoologists to make up their minds whether it would be better to give the school zoology mainly or exclusively a natural history bias, or to attempt to treat the subject experimentally. There are arguments in favour of either method, and it might be found possible to draft alternative courses. With carefully drawn detailed syllabuses to guide instructors, and with occasional University courses for teachers, it should not prove impossible to secure for natural history a place in the curriculum of every school.

F. K.

[1] "Memorandum on the Teaching of Natural History in Schools," prepared by the Zoology Organisation Committee at the request of the Committee of Section D, British Association, Edinburgh, 1921.

A Modified Octet Theory.

IN an interesting paper on electronic structures in unsaturated molecules, published in the Journal of the American Chemical Society for March, Mr. E. D. Eastman discusses multiple bonds in relation to the octet theory of atomic structure due to G. N. Lewis. It is assumed that the pair of electrons possessed by elements of the first period (except hydrogen), although usually not acting as valency electrons, and forming a shell persisting throughout the entire period of elements, may take part in the formation of outer groups of octets when it is otherwise difficult for these to be formed. The double bond is then pictured as one atom in which the central electrons have been drawn into the outer octet, joined by two electrons to another atom in which the normal arrangement is preserved. In cases of triple bonding the two inner electrons are assumed to have been drawn into the outer shell of two adjacent atoms, there being again two electrons held in common.

The arrangements are illustrated by the formulæ of ethane, ethylene, and acetylene, in which the symbols indicate nuclei and all outer electrons are shown as dots :—

```
  H   H            H  H
  ..  ..           .. ..              .. ..
H:.C.:.C.:H      :.C.:C:          H:C:C:H
  ..  ..           .. ..              .. ..
  H   H            H  H
```

Ethane. Ethylene. Acetylene.

Multiple bonds are apparently formed only by elements of the first period.

To meet the requirements of facts relating to stability, reactivity, and free rotation, the electrons of unsaturated octets are assumed to be held in equilibrium positions at greater distances from the nucleus than in the ordinary case, the transfer from the extended position to the usual ones liberating energy. No attractive force between electrons is assumed, and the electronic arrangement is taken as cubic, though subject to distortion. The structure of carbon dioxide is probably unsymmetrical, rather than the arrangement of three nuclei in line commonly assumed. The structures of the nitrogen and oxygen molecules are represented by the following symbols :—

```
 .. ..          .. ..
:N:N:   and   :.O.:O:
 .. ..          .. ..
```

Many chemical facts discussed in the paper should prove of interest to chemists, who cannot ignore the undoubted difficulties introduced by multiple bonds in the present theory of molecular structure.

University and Educational Intelligence.

BRISTOL.—The Vincent Stuckey-Lean scholarship in botany, tenable for one year and value 36*l.* with free access to the department of botany, is offered. Further information may be obtained from the Registrar, the University, Bristol. Applications for the scholarship must be received not later than Saturday, May 20.

LONDON.—The following lectures, which will be open to the public free and without ticket, have been arranged :—At King's College, a course of three lectures on Tertiary Igneous Action in Britain, by Dr. Alfred Harker, on May 17 and 31 at 5 o'clock, and on May 24 at 4 o'clock, a course of four lectures on The Development of the Head Muscles of Vertebrates, by Prof. F. H. Edgeworth, at 5.30 P.M., on May 22-25, and one lecture by Prof. J. F. Van Bemmelen, of the University of Groningen, on The Morphological Character of the Skin Pattern in Insects and Mammals, on May 17 at 5.30 P.M. At Birkbeck College, a course of three lectures on Recent Work with regard to the Influence of Soil Conditions on Agriculture, by Dr. E. J. Russell, on Fridays, commencing May 12 at 6 o'clock, and one lecture on Whorled Phyllotaxis, by Prof. J. C. Schoute of the University of Groningen, on May 11 at 5.30 P.M. At the School of Oriental Studies, a course of three lectures on The Idea of Personality in Sufism, by Dr. R. A. Nicholson, on Wednesdays, commencing May 17 at 5 o'clock. At the London School of Economics two lectures on Modern Views of Indo-European Origin, by Dr. Peter Giles, on Fridays, commencing May 12 at 5 o'clock.

THE following advanced lectures in medicine will be given in French at the Rooms of the Royal Society of Medicine, 1 Wimpole Street, W 1, at 5 P.M.: on May 22, "Anti-anaphylaxie," by Prof. F. Widal; on May 25, "De l'Érythrémie, (Maladie de Vaquez-Osler)," by Prof. H. Vaquez; and on May 31, "Des reflexes de défense," by Prof. J. Babinski.

MR. W. H. REED, a former mayor of the city of Exeter, has purchased and presented to the Governors of the University College, Exeter, the mansion house of Streatham Hall and part of the Streatham Hall estate, to be used as the site of the University College of the South-west of England. The Governors have purchased the adjoining farm and lands so that the new College will enter into possession of a site of 120 acres. It is expected that the incorporation of the new University College, the establishment of which has been approved by the University Grants Committee, will be effected this summer. Streatham Hall is placed on rising ground to the north-west of the city. It is near the stations and conveniently situated in every respect. The estate is admirably laid out and commands a prospect over the Exe valley to Dartmoor. It is intended to place on the new site not only the College buildings but also the hostels and playing fields.

A CONFERENCE of representatives of universities of Great Britain and Ireland will (as we announced last week) be held at University College, London, on Saturday, May 13. The holding of such annual conference was resolved upon at the First Congress of the Universities of the British Empire, but, owing to the war, the realisation of this project was postponed although conferences for special purposes were held in the years 1917–1920. At the Second Congress of Universities of the Empire in 1921 the resolution in favour of annual conferences was re-affirmed and it was decided that the month of May would be a convenient time for holding them. All the home universities were invited to suggest agenda and from these suggestions the Standing Committee of Vice-Chancellors selected the subjects which appeared to be most suitable for discussion at the present time, namely, the urgent need for the provision of enlarged opportunities for advanced study and research in British universities, the increase of residential accommodation for students, specialisation in certain subjects by certain universities, and organisation of adult education as an integral part of the work of the universities.

THE Report of its Principal Officer on the work of the University of London during 1921–22 gives the following among other statistics for the three years 1913–14, 1920–21, 1921–22: total admissions of students, 3852, 6728, 7092; candidates for examinations (final) for degrees—1807, 1746, 2455 (external candidates only—907, 710, 912); names on the roll of internal students on May 1, 4888, 7870, 8758.

Hostel accommodation for students at King's College is being substantially increased, a grant of 12,000*l.* having been allocated to this purpose. Among noteworthy events of the year were the following: the opening of the Unit of Obstetrics and Gynæcology at the Royal Free Hospital for Women and of the Institute of Historical Research; the inauguration of professorships of history, central European history, history and culture of British Dominions in Asia, sanskrit, physics, and five medical school professorships; the institution of a Bachelorship in dental surgery and of a B.A. degree and diploma in Slavonic studies; the creation of a staff tutorship for University Extension Tutorial Classes; and the formation of a Union Society on the lines of those of Oxford and Cambridge. The report foreshadows the establishment, in close association with the University, of a central Post-graduate Medical School and Institute of State Medicine, a site for the purpose adjoining the University's Bloomsbury estate having been acquired by the Rockefeller Foundation which recently offered to provide 2,000,000 dollars for the furtherance of these objects. Arrangements were made during the year with the University of Paris for six members of the Faculty of Medicine to lecture in London, and six similar exchanges in various departments of science were arranged with four Dutch Universities. The report closes with an eloquent and stimulating reminder of present-day university educational aims.

THE council of the British Medical Association announces that an Ernest Hart Memorial Scholarship, tenable for one year, of the value of 200*l.*, for the study of State medicine, and three Research Scholarships, each of the value of 150*l.*, and tenable for one year, for the investigation of a subject relating to the causation, prevention or treatment of disease, are to be awarded. Grants in aid of research in these subjects will also be made. Preference will be given to members of the medical profession and to applicants who propose to undertake to investigate problems of practical medicine. Applications for scholarships and grants should reach the Medical Secretary of the Association, 429 Strand, W.C.2, not later than June 24 next.

THE Board of Education has just published a table of holiday courses which will be held in England and Wales during the coming summer (H.M.S.O. 6d). In addition to general courses for teachers at most of the centres, there are special courses in the following subjects:—biology, at Aberystwyth and Saltburn; practical geography, at Nottingham, Scarborough, Falmouth, Brecon, Barry, Bangor, Oxford, and Bristol; economic geology, at Camborne; mine surveying, at Camborne, Amman Valley, Cardiff, and Penarth; mechanical, electrical, and civil engineering, at Cardiff and Penarth; psychology, at Brighton, Derby, Nottingham, Repton Hall, and Bangor; science courses for teachers, at Cardiff, Barry, Penarth, Oxford, Weston-super-Mare, and Repton Hall; sociology, at Edinburgh; oceanography and fisheries, at Barrow-in-Furness; botany, chemistry, mycology, and entomology applied to everyday life, at Wye; and climatology and the relations between geological structure and agriculture, at Midhurst, the country hostel of the London School of Economics. In this course, Prof. W. T. Gordon and Dr. E. J. Russell will lecture; of the other courses, about half are being organised by various educational bodies and the remainder by local education authorities and neighbouring universities. The table gives the dates of each course, the fees, the principal subjects of instruction, the address of the local secretary, and other particulars.

Calendar of Industrial Pioneers.

May 11, 1830. Friedrich Albrecht Winsor died.—A native of Brunswick, Winsor settled in England about the end of the eighteenth century. He lectured upon the use of gas, in 1806 had an exhibition of appliances at 97 Pall Mall, London, and early the following year lit a part of that street with gas. This was the first street lighted in that way. He was connected with the Westminster Gas Light and Coke Company, and in 1815 went to Paris, where he died; there is a cenotaph to his memory in Kensal Green Cemetery.

May 13, 1883. James Young died.—The originator of the paraffin industry, Young was born in Glasgow in 1811, became an assistant to Thomas Graham, the chemist, and was then successively manager to Muspratt and to Tennant. Through a suggestion of Lyon Playfair, Young was led to the investigation of a petroleum spring at Alfreton, Derbyshire, and in 1850 took out a patent for the dry distillation of coal. Entering into partnership with Meldrum and Binney, he founded works in Scotland, where naphtha, lubricating oils, paraffin for burning and solid paraffin were produced.

May 13, 1884. Cyrus Hall M'Cormick died.—The son of an American farmer who had introduced various labour-saving appliances, M'Cormick began work on the reaping machine in 1831, three years later took out a patent, and in 1847 started a factory for manufacturing his machines in Chicago. It was afterwards said that owing to M'Cormick's invention "the line of civilisation moves westward thirty miles each year." Many honours fell to him, and he was made a corresponding member of the Paris Academy of Sciences as having done more for the cause of civilisation than any other living man.

May 14, 1852. Walter Hancock died.—A member of the family whose name is associated with the rise of the British rubber industry, Hancock was born in Wiltshire in 1799. Between 1824 and 1836 he made a large number of experiments with steam road carriages, in 1832 built the *Era* which ran between London and Brighton, and the following year constructed the *Enterprise* which ran between Paddington and the City.

May 14, 1915. John Samuel White died.—The founder of a well-known firm of shipbuilders and engineers at East Cowes, White was one of the pioneers of the fast steamboat for naval purposes. To increase the manœuvring power of his boats he brought out the double rudder system with the deadwood removed.

May 15, 1888. Charles François Hervé Mangon died.—A student of the École Polytechnique and the École des Ponts et Chaussées, Mangon, though originally employed on railway engineering, was best known for his works on irrigation and drainage and the application of science to agriculture. He held a chair in the École des Ponts et Chaussées, was a member of the Paris Academy of Sciences, and for a time was director of the Conservatoire des Arts et Métiers.

May 17, 1910. Philip Cardew died.—From the Military Academy at Woolwich Cardew passed into the Royal Engineers and afterwards specialised in the application of electricity to purposes of war. He was instructor in this subject at Chatham and became known for his inventions, among which were the hot-wire voltmeter and the vibrating transmitter for telegraphy. In 1888 he became the first electrical adviser to the Board of Trade.

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, April 10.—M. Emile Bertin in the chair.—E. **Borel**: Arithmetical definition of a distribution of masses extending to infinity and quasi-periodic, with average density zero.—I. **Fredholm**: An application of the theory of integral equations.—J. **Andrade**: The mechanical problems of regulating springs.—P. **Vuillemin**: A new species of Syncephalastrum: the affinities of this genus.—E. **Vessiot**: The conformal geometry of systems of circles.—M. **Janet**: The invariant canonical forms of algebraical and differential systems.—T. **Carleman**: Demonstration of a theorem of M. Borel.—A. **Myller**: Remarks on M. Carleman's note.—A. **Myller**: Some properties of ruled surfaces in connection with the theory of parallelism of M. Levi-Cività.—H. **Chrétien** and P. **Ditisheim**: An electrochronograph recording the time, in figures, to hundredths of a second.—M. **Sauger**: A remarkable coincidence in the theory of relativity.—MM. **Berloty** and **Combier**: The eclipse of the sun of March 28, 1922, observed at the Observatory of Ksara (Syria).—I. **Tarazona**: Observation of the annular eclipse of the sun of March 27-28, 1922, made at the astronomical Observatory of Valencia (Spain).—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the fourth quarter of 1921. Observations were possible on 76 days during the quarter. The results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—H. **Chaumat**: An arrangement permitting the elimination and determination of the correction factor of wattmeters.—C. **Dévé**: The noise caused by aeroplanes. The pitch of the sound heard as an aeroplane is passing overhead varies according to the distance of the observer's ear from the ground, rising about two octaves when the ear is lowered to about eight inches from the soil. Possible causes of this phenomenon are discussed.—J. **Galibourg** and F. **Ryziger**: A method of recognising cultivated Japanese pearls. The hole usually drilled in the pearl for attaching to an ornament is utilised. A mirror is formed by placing a minute drop of mercury in this hole, the pearl is illuminated from the side and the structure examined microscopically. Differences between the natural and cultivated pearl are brought out in this way, and reproductions of photographs illustrating the differences observed are given.—P. M. **Monval**: The preparation of ammonium chloride. Determinations of the solubilities in saturated solution of sodium chloride, sodium carbonate, ammonium chloride, and ammonium carbonate, singly and in combination, the results being summarised on a Le Chatelier square diagram.—P. **Riou**: The velocity of absorption of carbon dioxide by alkaline solutions. A contribution to the experimental study of the ammonia-soda process.—C. **Chéneveau**: An application of the optical method of determination of the solubility of one liquid in another.—R. **Fosse** and A. **Hieulle**: The tendency of formaldehyde to form hydrocyanic acid by oxidation in an ammoniacal silver solution. Formaldehyde was oxidised in strongly ammoniacal solutions containing ammonium chloride and silver nitrate by a large excess of potassium permanganate. Working with 10 milligrams of formaldehyde in each experiment, a yield of 30-36 per cent. of hydrocyanic acid was obtained.—A. **Lanquine**: The direction and dislocations of the Cheiron strata to the south of the upper Estéron, up to the high valley of Loup (Maritime Alps).—A. **Guébbard**: Remarks on the last Provençal earthquake.—P. **Garrigou-Lagrange**: Great movements of the atmosphere and weather prediction.—E. **Gain**: The ultra-maximum temperature supported by the embryos of *Helianthus annuus*. If the seeds are gradually dried and heated by stages, with interposed periods of cooling, the seed can survive exposure to much higher temperatures than has been hitherto supposed. One lot of seeds submitted to this treatment gave 80 per cent. germination after a final exposure to 145° C., but this result was exceptional; another lot of seeds gave only 2-5 per cent. of germinations after the same exposure.—A. **Petit**: Concerning the "awakening" of arable earth. In a recent paper A. Lumière has pointed out the favourable effect on soil of a thorough washing with water. This washing acts as though it removed products opposed to the germination of seeds. The author directs attention to the fact that he published similar observations in 1909.—W. **Kopaczewski**: The differentiation of phenomena of shock by contact.—R. **Bayeux**: Maximum respiration at very high altitudes. An account of experiments on two subjects at Chamonix (1050 metres), the Vallot Observatory on Mont Blanc (4370 metres), and at intermediate heights.—W. **Koskowski**: Nicotine and the inhibitory nerves of the heart. Nicotine does not act on the heart by the intermediary of the pneumogastric nerve, but directly on the intracardiac ganglia.—J. **Mawas**: The lymphoid tissue of the spiral valve of the middle intestine of *Ammocœtes branchialis* and its morphological significance.—A. **Dehorne**: The muscular histolysis and phagocytosis in the cœlom of the Nereids at sexual maturity.—K. **Abrest**: The toxic index of illuminating apparatus, of heating apparatus, and of explosion motors. The ratio of carbon monoxide to carbon dioxide produced in any form of lighting or heating apparatus is termed the toxic index. This magnitude has been estimated for various forms of lighting burners and radiators, and in the exhaust of explosion motors.

Academy of Sciences, April 18.—M. Emile Bertin in the chair.—E. **Goursat**: The problem of the thrust of earth. It is shown that the partial differential equations of M. Boussinesq, modified by M. Remoundos, can be reduced to an integrable form.—E. **Borel**: Physical hypotheses and geometrical hypotheses.—E. **Ariès**: The maximum of the latent heat of evaporation.—G. **Valiron**: Integral functions.—E. **Belot**: The *rôle* of nebular media in the dynamics of stellar and planetary systems.—L. **Bull**: An apparatus for the rapid dissociation of images in kinematography by the electric spark. The film is stationary and the images, illuminated by electric sparks (at the rate of 50,000 per second), are received on a rotating total-reflection prism. The one disadvantage of the method is that the images are not parallel to each other from one end of the film to the other.—A. **Nodon**: The photogenic action of ultra-radiations.—E. **Darmois**: The action of acids on ammonium molybdo-malate. The polarimeter shows that this ammonium salt is very sensitive to the action of acids, and the diminution of the rotation appears to be proportional to the concentration of the hydrogen ions. The use of this method readily detects traces of sulphuric acid in vinegar.—A. **Braly**: A new method for the detection of gold and silver in minerals by means of the blowpipe.—A. **Schoep**: Soddite, a new radioactive mineral. This is a yellow crystalline mineral found associated with curite from Kasolo (Belgian Congo). It is a uranium silicate of the composition $12UO_3 . 5SiO_2 . 14H_2O$, and its radioactivity is in proportion to its high uranium content (86 per cent. UO_3). The name soddite is proposed for the mineral.—J. **Thoulet**: Deep submarine volcanic eruptions. Evidence of submarine eruptions furnished by deep-sea soundings near the Canaries and the Azores.—R. **Souèges**: The embryogeny of the Rosaceæ. The first stages of the development of the embryo in *Geum urbanum*.—M. and Mme. F. **Moreau**: Mycelium with protuberances found in the Ascomycetes.—J. **Stoklasa**: The influence of selenium and of radium on the germination of seeds. Both sodium selenate and selenite exert a toxic action on the development of seeds, the latter possessing the most marked effect. This toxic effect is partially neutralised if radioactive substances are present at the same time.—R. **Argaud**: The intranucleolar presence of the centrosome.—A. **Lumière** and J. **Chevrotier**: Antityphoid vaccination by scarification. As an alternative to vaccination by the mouth, which as yet has not been fully accepted, trials have been made of a process of immunisation by scarification. This method is free from the troublesome reactions caused by direct injection, but the immunity conferred is not quite complete.—MM. **Cohendy** and E. **Wollman**: Some results obtained by the method of growth under aseptic conditions. Experimental scurvy. Infection of the aseptic guinea-pig by cholera.—L. **Corbière** and A. **Chevalier**: The origin of *Spartina Townsendi* and its *rôle* in the fixation of marine mud.

Diary of Societies.

FRIDAY, MAY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. Halm: A Method of determining Photographic Star Magnitudes without the Use of Screens or Gratings.—J. Halm: The Rotation of the Sun's Reversing Layer.—J. Evershed: Widened Lines in the Spectrum of Sirius.—A. Stanley Williams: Two Variable Stars in Gemini.—A. Stanley Williams: A Probably Variable Star in Gemini.—A. Stanley Williams: The Tawny Hue of Jupiter's Equatorial Belt.—A. N. Brown: Observations of RT Cygni (Ch. 7085) in 1917–22.—W. H. Steavenson: Observations of Nova Persei (1901) in 1921–22.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—S. O. Pearson and H. St. G. Anson: Demonstration of Some Electrical Properties of Neon-filled Lamps.—Dr. A. Griffiths and W. T. Heys: A New Apparatus for the Measurement of the Polarisation Capacity of Platinum Plates in Sulphuric Acid.—Dr. H. Chatley: The Molecular Forces involved in Cohesion.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.
JUNIOR INSTITUTION OF ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—L. A. Legros: Tanks and Chain Track Artillery.
MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. H. Dale: The Search for Specific Remedies.

SATURDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. I. Grating Results.

MONDAY, MAY 15.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—E. A. Reeves: The Evidence of a True North and South Directive Force in the Atmosphere.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—Prof. T. P. Nunn, and others: Discussion on Prof. Whitehead's "Enquiry" and "Concept of Nature."
ROYAL SOCIETY OF ARTS, at 8.—F. F. Renwick: Modern Aspects of Photography (3) (Cobb Lectures).
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—J. A. Gotch: The First Half-century of the R.I.B.A.

TUESDAY, MAY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. Bulloch: Tyndall's Biological Researches and the Foundations of Bacteriology (Tyndall Lectures) (I.).
ROYAL SOCIETY OF MEDICINE (General Meeting of Fellows), at 5.
ROYAL STATISTICAL SOCIETY, at 5.15.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. F. Shepherd: Natural Colour Photography.

WEDNESDAY, MAY 17.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. A. E. M. Geddes: Weather and the Crop-Yield in the North-East Counties of Scotland, followed by a general discussion on R. H. Hooker's Presidential Address, The Weather and the Crops in Eastern England, 1885–1921.—Dr. H. P. Waran: A New Form of Direct-reading Barometer.
ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Annual General Meeting.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Exhibition of Microscopic Pond Life.

THURSDAY, MAY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. Keeble: Plant Sensitiveness (II.), To Contact and to Chemical Stimulation.
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. T. B. Wood and Dr. J. W. Capstick: The Progress of Metabolism after Food in Swine.—C. G. Lamb: The Geometry of Insect Pairing.—G. E. Briggs: Experimental Researches on Vegetable Assimilation and Respiration. XV. The Development of Photosynthetic Activity during Germination of Different Types of Seeds.—G. E. Briggs: Experimental Researches on Vegetable Assimilation and Respiration. XVI. The Characteristics of Sub-normal Photosynthetic Activity resulting from Deficiency of Nutrient Salts.—J. A. Gardner and F. W. Fox: The Origin and Destiny of Cholesterol in the Animal Organism. Part 13. The Autolysis of Liver and Spleen.
ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Sir Ernest Rutherford: Electricity and Matter (Kelvin Lecture).
INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—P. H. Hardy and L. B. Harris: Electrical Equipment.
CHEMICAL SOCIETY, at 8, followed by an Informal Meeting.

FRIDAY, MAY 19.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—W. Rushton: Further Contributions to the Biology of Freshwater Fishes.—Prof. J. H. Priestley: Toxic Action of Illuminating Gas on Plants (with Demonstration).
ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Annual General Meeting.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 7.—A. H. Reeves: The Elimination of Atmospherics in Radio-telegraphy.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: The Structure of Organic Crystals.

SATURDAY, MAY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. II. Photo-electric Methods.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 12.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (1).
UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (1);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (2).
BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (1).
GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (4) (Gresham Lectures).

TUESDAY, MAY 16.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (3).
KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Principle and Method of Hegel (3): The Philosophical Sciences.
GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (1) (Gresham Lectures).

WEDNESDAY, MAY 17.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. R. A. Nicholson: The Idea of Personality in Sufism (1).
UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (4).
KING'S COLLEGE, at 5.—Dr. A. Harker: Tertiary Igneous Action in Britain (1);—at 5.30.—Prof. J. F. Van Bemmelen: The Morphological Character of the Skin Pattern in Insects and Mammals.
GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (2) (Gresham Lectures).

THURSDAY, MAY 18.

UNIVERSITY COLLEGE, at 2.30.—Prof. W. M. Flinders Petrie: Recent Discoveries in Egypt (1);—at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (3).
ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Major-Genl. Sir W. B. Leishman: Enteric Fevers in the War.
GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (3) (Gresham Lectures).

FRIDAY, MAY 19.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (2).
UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (2);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (3).
BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (2).
GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic (4) (Gresham Lectures).