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Problems of Tuberculosis.

In the *Empire Review* for March Dr. Leonard Williams brings forward the perennial theme of the Spahlinger treatment of tuberculosis. This "treatment" has been the subject of extravagant and repeated press notices since 1914, and when it is shorn of its decorations, what does it amount to? Merely that M. H. Spahlinger has made, or his friends have made for him, a number of categoric statements, unsupported by proofs of the kind demanded in scientific work, that he can cure tuberculosis in man and animals. In a relatively small number of cases of consumption, clinicians have stated that the disease was arrested. Dr. Leonard Williams, an ardent supporter of M. Spahlinger, cites the communication of the latter to what he calls the "high-browed Paris Academy of Sciences." This communication (1921, t. 172, p. 494) occupies exactly one page and four lines, and is a reiteration of former statements without any evidence whatsoever that they are correct or of essential scientific value.

Dr. Leonard Williams also quotes April 28, 1914, as memorable in the history of tuberculosis, for on that day Prof. Letulle presented to the French Academy of Medicine a communication entitled "Traitement de la tuberculose par la méthode Henri Spahlinger." In the *Bull. de l'Acad. de Méd.* (1914, 3. s. t. 71, p. 610) we find that the communication occupies exactly eighteen lines, and was a preliminary note addressed to the Academy by Dr. E. Lardy of Geneva and Drs. Colbeck and Leonard Williams of London. Prof. Letulle was charged to examine the note, but up to date we have been unable to find any further reference to the matter in the Bulletin, although Dr. Leonard Williams tells us that "the text of the communication was duly published and rapidly found its way into the lay press." It would be interesting to know where the full communication may be found.

M. Spahlinger's treatment is stated to be both antigenic and antitoxic, and he claims to have produced many different tuberculous toxins by a method not published. The process is a long one, and the cost of production we are told is high, involving prolonged treatment of large numbers of cattle. The only other tuberculous problem referred to by Dr. Leonard Williams is really a panegyric on the work of Calmette. We are told that the "campaign against tuberculosis will never make any serious headway until the disease is attacked at the source. That source is the tuberculous cow." This may be Dr. Leonard Williams' opinion, but it is entirely opposed to the conclusions reached by the arduous experimental efforts of a generation of accurate workers.

W. B.

Archæological History.

(1) *Die Franken und Westgoten in der Völkerwanderungszeit.* By Nils Åberg. (Arbeten utgifna med understöd af Vilhelm Ekmans Universitetsfond, Uppsala, 28.) Pp. viii + 282 + 9 kartes. (Uppsala : A.-B. Akademiska Bokhandeln ; Leipzig : Otto Harrassowitz ; Paris : Libr. Honoré Champion, 1922.) 15 Kr.

(2) *The Bronze Age and the Celtic World.* By Harold Peake. Pp. 201 + 14 plates. (London : Benn Bros., Ltd., 1922.) 42*s*. net.

ARCHÆOLOGICAL method has made three principal advances hitherto. Early attempts to explain similarities and diversities of form and style in human handiwork were put on a scientific basis in Germany by Klemm (whose "Allgemeine Kulturgeschichte der Menschheit" appeared in 1843) and were re-interpreted on Darwinian lines by Pitt Rivers's "Principles of Classification" published in 1874; Kapp's "Grundlinien einer Philosophie der Technik," Semper's "Der Stil," and Hoernes' "Urgeschichte der Kunst" marking later refinements of this morphological criticism. Stratigraphical corroboration of evolutionary sequences thus indicated begins with examination of the Swiss lake-dwellings by Keller, Troyon, and others, the word *Kulturschicht* first appearing in an excavation report of 1855. The spade-work of Ramsauer at Hallstatt from 1862, of Warren and Wilson at Jerusalem from 1867, and of Schliemann at Troy from 1871, are notable early dissections of long-inhabited ground; and the developed technique of this kind of stratigraphy may be studied in Petrie's "Methods and Aims in Archæology."

The two books now under review approach archæological problems from yet another point of view. Even casual finds are at all events found *somewhere*. They can be plotted on a map; and when these plottings are sufficiently numerous, and their geographical distribution begins to be apparent, regions of occupation by this or that phase of culture may be defined, and the spread or shrinkage may be inferred of the people who practised each kind of handiwork which the finds reveal, and felt the needs which the craftsmen of each generation were there to satisfy. Thus, as Rostovtseff says of his own study of "Iranians and Greeks in South Russia" (Oxford, 1922), "we are gradually learning how to write history with the help of archæology." The method is precisely that of the staff-officer who establishes an enemy's order of battle from cap-badges and scraps of local newspaper, and estimates its artillery value from the splinters of his shells; and the value of archæological training was demonstrated on every front in the recent war.

Obviously this kind of antiquarian geography has had to wait until the finds themselves were sufficiently numerous; until they had been sufficiently announced, in museum catalogues and publications in detail; still more, until geographers (and, let us add, geologists) had accustomed their archæological colleagues to regard their proper "fossils" from the new point of view, looking not only "to the hole of the pit whence they were digged" but also "to the rock whence they were hewn."

(1) Dr. Åberg's work on the stone age culture of northern Europe, and on the first age of metal in the Iberian peninsula, is sufficient guarantee for scientific scholarship of the first order; his book on "East Prussia in the Migration Period" is an original contribution to one of the darkest phases of European history; and his present monograph on the "Franks and Visigoths in the Migration Period" is of the same fine quality. Naturally, his treatment of the material varies. Visigothic handiwork must be won by travel and research in local museums and private collections, and we are here still among the pioneers. But Frankish antiquities have been copiously published and studied, and the casual finds have been supplemented by systematic investigation of whole burial grounds, so that "sequence-dating" supplements the comparison and affiliation of types, and facilitates interpretation of regional surveys. As most of the work has been done hitherto by French archæologists, and from the point of view of the invaded regions, the principal need was now to look at the whole matter from the other side. As Rostovtseff puts it, in a parallel case, "I do not regard South Russia as one of the provinces of the Greek world . . ." but "as always an Oriental land," so Dr. Åberg might say that he does not regard the Franks as one of the peoples who intruded upon Gallo-Roman civilisation, but as always a Teutonic people. The result is an interpretation not only of the Frankish finds of the west, but also of all the congruous material east of the Rhine, north of the Alps, and so far afield as Hungary and Scandinavia, and also in Lombardy and beyond, as contributions to the narrative of a progressive Frankification (so to speak) of indigenous Teutonic culture through the instrumentality of those peoples of Teuton origin who had most completely appropriated the west-land civilisation which they mastered politically.

Thus, in a sense which will be a revelation to many, *Gallia victa victorum cepit*: or as Dr. Åberg puts it (p. 15), "the Franks in Gaul were influenced indeed, like the Goths in Italy, by Roman culture, but in contrast with them, they retained their power in spite of their loss of Teutonic quality, thanks to the maintenance of intercourse along the lines of communication with the heart of Germany. Consequently there was no gulf here between Germanic and Roman, but a gradual transition. Roman organisation pressed slowly eastward. . . . The focus of development, which in Merovingian times had been mainly Gaul, shifted over in Carolingian times on to German soil. Here came about the last amalgamation of Roman and Germanic which is the foundation of modern Europe. Only Scandinavia still stayed long outside this development, as a last remnant of ancient Germany, and a wound in the side of Europe which was hard to heal."

For the stages of this revolution in social and political structure Dr. Åberg offers us as testimony not edicts or charters, nor a *cursus honorum* such as has revealed the spirit and the structure of imperial Rome, but the mute eloquence of hundreds of brooches and buckles, of ingenious design, intricate ornamentation, and accurately plotted distribution. His inventory of type-specimens occupies 42 pages, and his nine maps of the principal phases which he has been able to distinguish are models of this kind of interpretation. His first two chapters, occupying only forty pages, trace the outlines of the whole inquiry, and summarise the course of events before the opening of the fifth century, at which his proper study begins. These and the subsequent later review of Merovingian influence east of the Rhine are what will chiefly interest the historian; the remainder of the book, with its ample and well-executed illustrations, concerns rather the student of design and of the transference of decorative motives from one repertoire to another.

The account of the Visigothic occupation of Spain and Portugal (pp. 206-240) is more tentative, because (as already noted) the material is scanty and inaccessible, and, to judge from the specimens which are figured here, less instructive as to the movements of Germanic peoples in this region. Provisionally, Dr. Åberg groups all Germanic antiquities from this area as "Gothic," reserving till a later stage the possibility of assigning some types to particular peoples.

A word should be added to congratulate the Vilhelm Ekmans Fund at Uppsala on having produced so learned, valuable, and well-appointed a volume at the rate of less than three farthings per page.

(2) Mr. Peake's book is of a different quality. Spaciously printed, and well bound—and we must add, more than adequately priced at 2½d. per page—it is little more than a reprint of a course of six University lectures, with acknowledgments of the principal sources of printed information, the bare minimum of outline diagrams, and far less than the due minimum of distribution maps. The author disarms criticism when he declares his purpose to be "not so much to record evidence as to interpret it, to restore the main features of early history than to describe archæological remains." It is, in fact, an essay rather than a formal treatise. It covers very wide ground, from a preliminary survey of the pre-Celtic continent—Nordic, Alpine, and mixed Mediterranean stocks, partially brought into economic relations by slow breach of natural barriers, especially forest and mountain, and by the pervasive wiles of the "prospectors"—to the problem of the replacement of bronze by iron for cutting-weapons, and the superposition of "P-Celts" upon "Q-Celts" and of other P's upon other Q's.

To be proficient at all points of such a programme would be a giant's task. Mr. Peake has read widely (though scarcely widely enough) and has thought independently and boldly; and his book is always readable and intelligible. Frequently his suggestions carry conviction; his mistakes are mostly of omission; and his summaries even of the most controversial matters are discreet and fair. Obsolete learning he is for the most part content to leave on one side, and where he feels obliged to review the course of inquiry, as in the chapter on the "Aryan Home," he knows how to select main turning-points, and distinguish the permanently suggestive idea from the transitory prejudices which advertised or obscured it at its inception.

The problem which Mr. Peake has set before himself is to compare the archæological evidence for reputed movements of peoples within peninsular Europe, from the end of the third thousand years B.C. to the beginning of the first, with the philological conclusions on the same subject derived from the relationships and distributions of languages. His conclusion, briefly stated, is that the distribution over Europe and its neighbourhood, of the series of types of so-called "leaf-shaped swords" of bronze, is such as to indicate successive eruptions of peoples armed with these swords, from the Hungarian plain into various adjacent regions and beyond them. Also that the disappearance of the later types of the series from Hungary itself and from surrounding districts may be so closely associated with the distribution of other swords, similar but derivative and made of iron, as to justify the inference that it was the aggression of the men of the iron swords that determined the retreat or disappearance of the users of "leaf-shaped" bronze blades. Lucky finds of typical swords in datable surroundings, and especially the discovery in Egypt of a sword of European type, about half-way down the morphological series, engraved with the name of King Seti II., who reigned only from 1209 to 1204 B.C., enable him to reckon the probable duration of the whole series of events, and to institute a very suggestive comparison of them with the movements of the two main groups of Celtic-speaking peoples, from much the same area of origin around the middle Danube, into Western Europe and Britain, and of similar waves of "P-using" and "Q-using" immigrants into peninsular Italy, and probably also into Greece; though Mr. Peake is discreetly reserved in his treatment of these last.

Much of Mr. Peake's material is, of course, familiar; it is his courageous attempt to compare disparate series, and draw historical conclusions, which justifies his book; and it will be found full of suggestive passages, even by those who will best appreciate the difficulties of his task and the defects of his equipment for it. It is eminently a book to be judged by its merits, not by its faults. It has omissions, but its main argument is clear and generally coherent; it has slips and some misapprehensions in detail, but they do not seriously detract from its cogency. Its central contribution to learning, the establishment of a morphological sequence among the "leaf-shaped swords" by comparative study, not of their blades but of their hilts, is of considerable importance. This is a kind of work of which much more remains to be done: a similar essay on the fibulæ alone would probably lead to appreciable revision of the conclusions of Montelius and his contemporaries a generation ago, and would be the only conclusive test of the validity of Mr. Peake's inferences. It must also be noted here that even what has been attempted in this essay is but the first-fruits of the great inventory of the types of prehistoric implements, so long overdue, of which only the British section of the bronze implements has been systematically attempted as yet, by Mr. Peake himself and a British Association committee. Till such an inventory has been very greatly extended, and the distributions which it alone can reveal have been plotted and compared, prehistoric archæology can scarcely be said to have entered upon a truly scientific phase. It is one of the merits of any piece of work such as this essay, that it illustrates by example, even if also in some degree by anticipation, the value of such an addition to archæological equipment as the British Association's inventory is already proving itself to be.

Gelatin and Glue.

The Chemistry and Technology of Gelatin and Glue. By Dr. R. H. Bogue. (Mellon Institute Technochemical Series.) Pp. xi+644. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 30*s*.

ANYONE who, in recent years, has had occasion to deal with the question of gelatin has been confronted at the outset with the fact that no adequate summary of the existing knowledge was available. An immense amount of information was widely scattered in the various scientific and technical journals of all countries, but it was so varied in character, and very often so contradictory, that the task of making a summary which was something other than a mass of apparently disconnected facts seemed almost hopeless. The pioneering work of Procter in England, which dealt chiefly with gelatin, and of Pauli in Austria, which was concerned with proteins in general, gave the first indication of the basis on which such a summary could be made; but the more recent work of Loeb in America has perhaps helped more than anything else towards a clarification of ideas. The work of Brailsford Robertson should also be mentioned, since he has collected a large amount of experimental data, although his theoretical conclusions are accepted by few.

The clarification of ideas has been chiefly confined to the physico-chemical treatment of the subject. The more purely chemical aspect of the question has not advanced much beyond the identification of the break-down products of gelatin, and the more or less satisfactory methods of estimating the percentages of the various kinds of combined nitrogen.

During the last few years American scientific journals especially have obtained a large number of papers on gelatin, which have been published by workers other than Loeb. Among the chief of these workers has been Dr. Bogue, and it is therefore not to be wondered at that, of three books on gelatin which have been announced in the American press for some time past, his is the first to be published. Dr. Bogue is research chemist for Armour and Company of Chicago—would that English gelatin firms were as wide awake in this respect as the American ones!—and is consequently in touch with the technological as well as with the more purely theoretical side of the subject. His book has therefore been awaited with interest by those who have to deal with gelatin, and they will not be disappointed, since the author has been eminently successful in correlating and summarising the enormous amount of material at his disposal, and in giving a clear and readable account of the subject. After an introduction dealing with historical and statistical considerations, the theoretical aspects of the subject are considered. These include the constitution of the proteins, the chemistry of gelatin and its congeners, the physico-chemical properties and structure of gelatin, gelatin as a lyophile and as an amphoteric colloid.

The author seems to have contented himself with giving only such literature references as are necessary for drawing up a connected account of the subject.

This was probably a wise course to adopt, since otherwise the book would have become very unwieldy, but it has meant that a number of important papers published in German journals are not mentioned. For example, Dr. Bogue is a great advocate of the fibrillar structure of gels, but no mention is made of similar views put forward by Moeller in a number of different papers in the *Kolloid Zeitschrift*. A lucid description is given of the various physico-chemical properties of gelatins and glues and the various theories are dealt with in detail. If anything, the author has not been sufficiently critical in describing the theories of Brailsford Robertson, who assumes a peculiar kind of dissociation which appeals neither to the organic nor to the physical chemist, and against which there is a mass of evidence accumulated by Pauli, Loeb, and others. Actually, Dr. Bogue attempts to modify Robertson's theory, so as to make it more in accordance with the work of Loeb, but the modified theory is still open to most of the objections raised against the original theory.

The second part of the book deals with the technological aspects of the manufacture, testing, chemical analysis, evaluation, uses and applications of gelatin and glue. The point of view taken is that of the chemist rather than that of the plant technologist, and this makes the appeal of the book all the greater to the student and investigator. In the chapter on the uses and applications of glue there is a section on glue-room economy and technology, which may be recommended for study to all users of glue on a large scale, so that increased efficacy, based on the application of scientific principles, may be attained in their workshops.

There is also a special chapter on water-resistant glues and glues of marine origin, which should be read in conjunction with the first report of the Adhesives Research Committee. An appendix deals more especially with the electrometric and indicator methods of determining hydrion concentrations.

Generally speaking, there is little which calls for criticism, except the curious statement made on p. 221 that acetic acid is an amphoteric substance because the hydrogen of its carboxyl group may be substituted by metals and the hydroxyl by chlorine (by the use of phosphorus trichloride). A few misprints, such as "existance" and "catinary," have been noticed, and the following statement on p. 141 requires revision: "but this does not follow for a continuous membrane that was semipermeable in the sense of being able to dissolve the solvent or medium of dispersion would likewise behave as an ultra-filter." Also, why should it be necessary to write "Anfangsdekrement" instead of "initial decrement"?

T. S. P.

Flora of New Zealand.

Die Vegetation der Erde. Sammlung pflanzengeographischer Monographien. Herausgegeben von Prof. A. Engler und Prof. O. Drude. XIV. *The Vegetation of New Zealand.* By Dr. L. Cockayne. Pp. xxiii + 364 + 2 maps + 65 plates. (Leipzig: W. Engelmann; New York: G. E. Stechert and Co., 1921.)

WITH the landing of Sir Joseph Banks and Dr. Solander at Poverty Bay on October 8, 1769, our knowledge of the flora of New Zealand commenced, but unfortunately the results of the labours of these two intrepid explorers have never been published, though the plates of the new plants were prepared at Banks's expense and the descriptions were drawn up by Solander. From this time onwards various expeditions, both English and French, reached New Zealand, making small collections, the results of which were published, but Sir Joseph Hooker's first volume of his "Flora Antarctica," published in 1847, must be regarded as the first comprehensive flora of these islands. As a result of the help received from many collectors, Hooker published his "Flora Novae Zelandiae" (1853–55), which truly marked a new era in the botany of New Zealand, but still little was known of the South Island alpine flora, and it is to Travers, Haast, Hector, and Buchanan that we owe a great deal of our knowledge of the flora of this region.

Sir Joseph Hooker again contributed to our knowledge of the flora in his "Handbook of the New Zealand Flora" (1864–67), undertaken at the instance of the Government of New Zealand, and since then the task has been fittingly and very ably taken up by New Zealand botanists, among whom must especially be mentioned T. Kirk, T. F. Cheeseman, D. Petrie, and L. Cockayne, the author of the valuable work under notice. Dr. Cockayne commenced his botanical work in 1887, and has continued his explorations with great assiduity and keen insight ever since. Becoming gradually more interested in ecology, the present volume, dealing with the vegetation of New Zealand in its many aspects and in relation to the varied plant associations, could not have been entrusted to more worthy hands. Nor could the subject have been more ably treated.

In an introductory chapter the history of our knowledge of the flora is detailed and the book is then divided up into four parts. The first part, as is proper in a treatise planned on ecological lines, deals with the physical geography and climate of the three main islands and of the outlying groups, the chapter on the climate and rainfall being contributed by Mr. D. C. Bates. It is unfortunate that the maps are sadly deficient in the way of names and orographical details, both of which are essential for a proper appreciation of the work. Possibly the difficulty of publication so soon after the War, and also in Germany, may account for this blemish to a book which is remarkable in the excellence of its form and style, considering that author and publisher were at opposite sides of the world.

The second part naturally occupies the greater portion of the book, since it deals with the various formations or plant associations, and full details and excellent illustrations are given of the leading physiognomic plants and their growth forms. In the first section the sea-coast vegetation with the characteristic dune plants, salt meadow and coastal scrub, Olearia and Veronica associations, are described, and this leads to a discussion of the plant formations of the lowlands and lower hills, characterised by many peculiar endemic New Zealand plants. Among these the "Southern Beech" forests, comprised mainly of the different species of Nothofagus, are of great interest. Passing upwards through the grasslands or steppe, where the "Tussock" (Poa, Festuca, and Danthonia) associations flourish, the author naturally follows with an account of the vegetation of the high mountains. This is remarkable in that no less than 498 species of vascular plants are entirely confined to the mountains, but since many lowland plants are also found at high elevations, the alpine flora is found to number 945 species. Of these no less than 561 are endemic.

In Part III. the relationships of the New Zealand flora are fully dealt with, but it may be mentioned here that of this flora about 35 species belonging to as many genera have near relatives in subantarctic South America.

The vegetation of the outlying islands is then fully dealt with on the same lines as that of the main islands, and, in the subantarctic islands, it is shown that there are some 55 endemic, 123 New Zealand, and 32 subantarctic South American plants, nine of which are not found on the main islands of New Zealand.

The fifth section of this second part deals with the effect of "settlement" upon the plant covering of New Zealand and is by no means pleasant reading. The hand of man, his introduced animals and plants, have, in New Zealand as elsewhere, wrought irreparable destruction and modifications in the primeval and singular plant covering.

In the final part, Dr. Cockayne gives a brief but useful history of the flora from the Jurassic period to the present time, and lays stress on the subantarctic affinities both of the flora and fauna of New Zealand. Whether land connexions with an antarctic continent ever existed, or chains of islands linking the southern continents provided the bridge which enabled species to migrate to what is now S. America on one hand and Tasmania on the other, must ever remain a problem. Dr. Cockayne considers that the difficulty of transoceanic transit is too great to account for the affinities, and, no doubt rightly, inclines to the problematical bridge of land or islands in the dim past. Whatever may have been the origin of this interesting primeval flora, it is very satisfactory to note that the Government of New Zealand is taking all possible steps to preserve, so far as may be possible, its unique features.

Electrical Engineering.

Standard Handbook for Electrical Engineers. Prepared by a Staff of Specialists; Editor-in-Chief: Frank F. Fowle. Fifth edition, thoroughly revised. Pp. xviii+2137. (New York and London: McGraw-Hill Book Co. Inc., 1922.) 30*s*.

WE think that the volume under notice justifies its title as being a "standard" handbook. The general make-up and arrangement leave little to be desired. The whole field of electrical engineering is divided into twenty-five sections each complete in itself; these are all numbered and by special depressions on the edges of the pages any particular section is found at once. The index is good, the references being made to section and paragraph. The sections have all been written by well-known American engineers and physicists and have been brought carefully up to date; for example, the section on units is written by Kennelly, magnetic circuits by Karapetoff, illumination by Millar, and electric ship propulsion by Hobart.

We were momentarily surprised to learn from Prof. Kennelly that the M.T.S. (metre-ton-second) and the Q.E.S. (quadrant-eleventh-gram-second) systems had come into extensive use. This latter system, however, is only the international electromagnetic system used in electrical engineering. We were glad to see it definitely stated that the electric and magnetic constants of the ether should not be taken as pure numerics. The section on power transmission is very thorough and data are given which would be very difficult to find elsewhere. The twenty-fourth section gives the 1921 edition of the standards of the American Institute of Electrical Engineers. In connexion with the distortion of waves, we are sorry to see that they still call a certain very variable ratio the "deviation factor" of the wave. In defining the distortion of a wave it is necessary to take into account the phase differences as well as the magnitudes of the amplitudes of its harmonics. We notice also that a resistance coil, a choking coil, and an inductive coil are now called a resistor, an inductor, and a reactor.

The final section is on general engineering economics and will be of great interest to commercial engineers. It is stated that "profits" represent a return on the capital over and above the normal rate of interest. For example, if the difference between income and expenditure was 10 per cent. then assuming that 6 per cent. is the normal rate of interest on investments, the "profit" would be 4 per cent. Apparently in America there is no agreed theory of depreciation, the straight-line or simple interest method and the sinking-fund or compound interest method are both still used.

The references given include the best American and English authorities and are useful ones. We can heartily recommend the book. A. R.

Our Bookshelf.

The Yearbook of the Universities of the Empire, 1923. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xii+692. (London: G. Bell and Sons, Ltd., 1923.) 7*s*. 6*d*. net.

THE latest edition of the Yearbook, revised and amplified, should be of the greatest help not only to those officially concerned in university administration, but also to all who are interested in the developments within the British Empire of higher and professional education. It is no small feat to compress within the cover of an easily handled (and well indexed) volume the essential details of the calendars of the sixty-six universities of the Empire. Mr. Dawson, who has edited the book for the Universities Bureau, has accomplished the task very creditably, and the abbreviations and other typographical devices to which he has had recourse do not in any way militate against intelligibility, and, so far as we have tested it, the information given is both accurate and adequate.

The appendices, which now run to more than 150 pages, contain some interesting information, not easily accessible elsewhere, regarding admission to the various professions and the qualifications necessary. A section on foreign universities gives some brief but useful particulars of the principal universities on the continent and also of the universities of the United States, including a list of the institutions approved by the Association of American Universities.

Mention should also be made of the information relating to the admission to universities in the United Kingdom of persons educated abroad, to scholarships and grants for research, and to the distribution of subjects of study among British universities. Particularly interesting is a table showing the numbers of students from overseas, which suggests that the resources of this country for postgraduate and other study are now being appreciated. The total number of such students is more than 4000. At London University alone there are 81 from Egypt, 336 from South Africa, 46 from Canada, 72 from the United States, and 335 from India.

The Microscopical Examination of Foods and Drugs. By Prof. H. G. Greenish. Third edition. Pp. xx+386. (London: J. and A. Churchill, 1923.) 18*s*. net.

PROF. GREENISH's volume stands alone as a modern English text-book of the subject, and it is a matter of considerable satisfaction that author and publisher combine to keep the work abreast of the times. In the new edition, the text has been carefully revised and brought up-to-date, but we are informed that the inclusion of additional matter has not been possible on account of the prevailing high costs of paper and printing. We hope that by the time a further edition is called for, a means will have been found to overcome this difficulty, if it should still exist.

The book is too well known to need detailed description, but for the benefit of new students and others we may mention that its special value lies in the fact that it furnishes detailed information regarding methods of investigation which have been developed during many years by an acknowledged expert in the subject. In work of this kind, prolonged and continuous experience is a *sine qua non* for accurate determinations, and the methods so fully and clearly set out in this handbook bear unmistakable evidence of such experience. The book is essential to all pharmacological laboratories and students, and we suggest that teachers of "pure" botany would find many hints as to methods and material which would be of assistance to them in obtaining fresh ideas for the scheme of practical work to accompany their histological lectures. If in a later edition it is decided to retain "silk" as a material for description, we suggest that space should be found for a somewhat fuller treatment of the subject, including a reference to the important results obtained by von Höhnel in his investigations of the different kinds of commercial silks.

The Analysis of Non-Ferrous Alloys. By Fred Ibbotson and Leslie Aitchison. Second edition. Pp. ix+246. (London: Longmans, Green and Co., 1922.) 12*s*. 6*d*. net.

THE fact that a second edition of this text-book has been called for is evidence that it has been found useful by analysts. War experience has led to an enlargement of the field of non-ferrous alloys, and the authors have therefore added to the matter of the former edition an account of the analysis of alloys containing aluminium as their principal constituent, and also of those rich in nickel, such as cupro-nickel and nichrome. The light aluminium alloys form a particularly difficult class, and it has been found necessary to devote a special chapter to the separation of zinc and aluminium, the authors recommending the precipitation of zinc sulphide from alkaline solution or the electro-deposition of zinc. The otherwise excellent section on electrolytic analysis suggests that no cathodes other than platinum and mercury can be used successfully, but many laboratories now employ copper and nickel gauze cathodes with entire success; an important consideration when the cost of platinum is so high.

The subject of hydrogen sulphide precipitations is dealt with thoroughly, this being a matter on which it is most important to have a clear view of the conditions affecting precipitation. The newer organic reagents, such as cupferron, are not described.

The work may be thoroughly recommended to professional analysts as well as to students, the authors having a wide personal experience of the methods they describe, their views on the best methods of analysing difficult alloys being particularly valuable.

La Radiotéléphonie. Par Carlo Toché. Pp. vi+98. (Paris : Gauthier-Villars et Cie, 1922.) 10 francs.

THE book under notice gives an interesting general description of the best and most modern methods of radiotelephony. It presupposes on the part of the reader an elementary knowledge of the subject and a general knowledge of science. It begins by describing the physiology of the voice, giving photographic records of voice vibrations obtained by Marage. It is interesting to note that oscillograms obtained of microphonic currents produced by speech are not so simple as those shown. The arc, alternator and valve methods of radiotelephony are next described, more stress being laid on the theory than on the history of the art. Due credit is assigned to the work done by the American Western Electric Co. A good discussion is given of the possibility of simultaneous communications in radiotelephony. The essential frequencies required for speech vary between 200 and 2000 per second, and the frequency of the carrier waves between 15,000 and three million per second. The author concludes that the maximum possible number of simultaneous communications is 1492. It has to be remembered that many of these waves have short wave-lengths and are therefore not suitable for long-distance transmission. For international and intercontinental systems the possible number would be much smaller. The number of possible radio-telegraphic systems with carrier waves is very much larger than the number of possible telephonic systems.

The Grammar of the Lamba Language. By C. M. Doke. (Published under the Joint Auspices of the University of the Witwatersrand, and the Council of Education, Witwatersrand.) Pp. ix+157. (London: Kegan Paul and Co., Ltd., 1922.) 6*s*. net.

IT is a pleasure to extend a welcome to this scholarly study of the Lamba language, not least on the ground that it is published under the auspices of the Witwatersrand University and Council of Education, and bears witness to the official interest now taken in native studies.

The Lamba language is spoken throughout the Ndola district of North-Western Rhodesia and in the south of the Katanga, this area lying in the centre of Bantu Africa. It is claimed to be the most primitive dialect of Bantu now extant, a view to which the author inclines on the ground of its strict adherence to rule and the great simplicity of its phonetics. Numeration is based upon the quinary system. The use of onomatopœia is very prevalent, and not only can all verbs be reduced to a monosyllable root, but they also appear to have evolved from onomatopœic sounds, adjectives and nouns representing a further stage in evolution. Lamba contains a number of loan words from Portuguese (the earliest), Swahili, English, and Dutch, as well as from other Bantu dialects. The days of the week, it is interesting to note, are taken from Chinyanja.

A Manual of Practical Anatomy: A Guide to the Dissection of the Human Body. By Prof. Thomas Walmsley. In 3 parts. Part 3: The Head and Neck. Pp. viii+272. (London: Longmans, Green and Co., 1922.) 10*s*. 6*d*. net.

THE third part of Professor Walmsley's "Manual of Practical Anatomy" is devoted to the dissection of the head and neck, for which a period of about ten weeks is suggested. The usual order of dissection is adopted, the various regions and organs being treated separately, but without that strict confinement to region which is so confusing to the student when dealing with a structure which appears in different portions of the dissection. The instructions for the guidance of the dissector are clearly given; the anatomical descriptions are complete and well illustrated by diagrams which the student is encouraged to label from his own specimen. The only defect in the book is that the index is not very complete. We are glad to observe that the nomenclature is in the British (Old) terminology. The book can be thoroughly recommended as a guide to the student in the dissecting-room.

Inorganic Chemistry: A Text-book for Schools. By E. J. Holmyard. Pp. x+560. (London: Edward Arnold and Co., 1922.) 6*s*. 6*d*.

MR. HOLMYARD has written what is really an excellent text-book for schools. The style is clear and the arrangement on the whole good, although the very late appearance of the halogen elements is perhaps not quite fair to their great activity and their participation in the lives of the other simple bodies. The historical notices, as might have been expected, are excellent, and they and a number of portraits of famous chemists add considerably to the interest of the book. We wish this book the full success it deserves.

The Handbook of Palestine. Edited by Harry Charles Luke and Edward Keith-Roach. (Issued under the authority of the Government of Palestine.) Pp. xii+295. (London: Macmillan and Co., Ltd., 1922.) 12*s*. net.

THIS is mainly a handbook of general information, but there are short chapters on the geology and natural history and a note on the flora. Forestry receives more attention. Meteorology is scarcely noticed. The sections on races and on archæology are fairly full. A folding sketch-map shows roads, railways and archæological features, but no relief. The handbook should prove of value to every visitor to Palestine, but it might be given a wider and more permanent value if the historical and scientific sections were extended.

The Radio Year Book, 1923 (First Year). Pp. viii+148. (London: Sir Isaac Pitman and Sons, Ltd., 1923.) 1*s*. 6*d*. net.

IT is intended to make this the Year Book of the new industry which is rapidly growing, owing to the great popular interest which is being taken in broadcasting. Section I. gives general information of use to radio amateurs. Section II. gives short and trustworthy articles on subjects of general interest in the working of radio apparatus, and Section III. gives information which will be useful to manufacturers and suppliers of the apparatus. The articles are by well-known experts, and the book should prove useful.

Letters to the Editor.

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

On Urbain's Celtium Lines.

IN a previous letter (NATURE, March 10, p. 322) we have shown that the optical spectrum of the new element hafnium, of atomic number 72, which was discovered a short time ago by Coster and Hevesy, does not contain any of the lines belonging to the characteristic spectrum ascribed by Urbain (*Comptes rendus*, t. 152, 1911, p. 141) to an element celtium belonging to the family of rare earths, which element was assumed by Dauvillier and Urbain (*Comptes rendus*, t. 174, 1922, pp. 1347 and 1349; NATURE, February 17, 1923, p. 218) to possess the atomic number 72.

Through an examination of the very careful measurements of the spectra of the rare earths published during the last few years by Eder, we have learned in the meantime that the greater part of Urbain's celtium lines have been observed by this author (*Wiener Ber.*, IIa, vol. 124, 1915) in the spectrum of a preparation of the rare earth element cassiopeium or lutetium. The discovery of this element (atomic number 71) was announced in 1905 by Auer von Welsbach, to whom the former name is due, while the name lutetium was proposed in 1907 by Urbain, who published at the same time the first list of lines of its optical spectrum (*Comptes rendus*, t. 145, 1907, p. 759).

In the table below we give the wave-lengths of the celtium lines from Urbain's paper, together with their relative intensities (by use of the numbers 2, 4, 6, and 8 instead of Urbain's notations: *moyenne*, *assez forte*, *forte*, *très forte*) and the corresponding wave-lengths and intensities from Eder's measurements of the cassiopeium spectrum, corrected to Rowland's scale.

Urbain's Ct Lines.		Cp Lines observed by Eder.		Urbain's Ct Lines.		Cp Lines observed by Eder.	
2459·4	2	2459·71	1	2885·1	4	2885·23	3
2469·3	2	..		2903·9	4	..	
2481·6	4	2481·79	2	2931·7	2	2931·56	1
2536·9	4	2537·09	2	2949·5	4	2949·82	3
2677·7	2	2677·35	1	3080·7	8	{ 3080·22*	4
2685·2	8	2685·24	3			{ 3081·59	8
2729·1	6	2729·08	3	3118·6	8	3118·56*	5
2737·9	2	..		3171·4	6	3171·49*	5
2765·8	8	2765·88	3	3197·9	8	3198·25*	8
2834·3	4	2834·37	1	3326·0	4	..	
2837·3	4	..		3391·5	6	3391·73	4
2845·2	6	2845·23	2	3665·6	2	..	
2870·2	2	..					

It is important to notice the very close accordance in the values of the relative intensities in the two tables, which we think justifies the identification of the lines also in the few cases where the difference between the wave-lengths is slightly greater than is to be expected from the usual accuracy of Urbain's measurements of wave-lengths of rare earths. Only a few of these lines, denoted by an asterisk, were included in Urbain's original list of the lutetium lines.

In order to verify the origin of Eder's lines and to endeavour to find out why most of these lines were not included in Urbain's original list, we have examined the optical spectrum of a highly purified cassiopeium preparation kindly presented to this institute by Dr. Auer von Welsbach. At the same time Dr. Coster has photographed the X-ray spectrum of the same preparation and found it to contain no trace of an element with atomic number 72. Our exposures revealed in the spectral region investigated (2500-3500 Å) all the lines observed by Eder and brought certain new features to light, which made it possible to understand why these lines were not observed in the original investigation of the lutetium spectrum published by Urbain in 1907. In an exposure in which the salt was placed at the carbon anode of the arc, the celtium lines came out sharp and in about the same relative intensities as in Eder's investigations, but when the salt was placed at the cathode, most of the celtium lines were much more intense and very diffuse and broad, especially in the part of the arc nearest to the cathode. The only celtium lines which also under these conditions came out as sharp as the rest of Eder's cassiopeium lines were the four previously mentioned lines denoted in the table by an asterisk. On account of this behaviour of most of the celtium lines they will be very difficult to observe in less pure preparations. Some exposures taken with a less concentrated (10 per cent.) sample, formed by mixing Auer's preparation with a scandium salt, did in fact show only the usual lines, whereas most of the celtium lines could be detected only by the presence of an increase of the continuous background of the plate. Urbain's results are therefore easy to understand, if we assume that the preparations investigated by Urbain in 1907 contained a comparatively small amount of the element with atomic number 71, and that only after treating the preparations further a concentration was obtained sufficient for the production of the diffuse lines, which in 1911 were ascribed to the presence of a new rare earth element, which was called celtium.

As to the origin of the lines given by Urbain as celtium lines, and not present in Eder's cassiopeium spectrum, we have found in the spectrum of Auer's preparation a weak line with wave-length 2738·1 Å, which may be identified with a celtium line (2737·9 Å). The line 3326·0 occurs as a weak line in the mentioned mixture of scandium and cassiopeium, but could not be found in the spectrum of Auer's pure preparation. As Urbain states that scandium was present as an impurity in his preparations, and as the scandium spectrum is not very well known, we have also taken a strong exposure of this spectrum, but could not find any of the remaining lines. Probably these lines have the same origin as the other celtium lines, but as they are weaker they will need a very strong exposure, especially if they also are diffuse. For such strong exposures we had not sufficient material.

It is of interest to add that in a recent note (*Comptes rendus*, t. 176, 1923, p. 496), which first came to our notice after the above was written, dealing with the discovery by Coster and Hevesy of the element hafnium with atomic number 72, Urbain himself directs attention to the particular behaviour of the lines ascribed by him to celtium, and expresses the conjecture that these lines—the observation of which was the basis for his belief in the presence of a new element in his preparation—may actually constitute the spark spectrum of the element 71.

H. M. HANSEN.
S. WERNER.

Universitetets Institut for teoretisk Fysik,
Copenhagen, March 20.

On Celtium and Hafnium.

In our letter of February 9, which appeared in Nature of February 24, p. 252, we have shown that the element hafnium, of atomic number 72, detected by us in zirconium minerals, possesses physical and chemical properties quite different from those ascribed to a rare earth element celtium, the discovery of which was announced by Urbain in 1911, and which recently was believed by Dauvillier and Urbain also to possess the atomic number 72. In a communication of February 19 to the Paris Academy of Sciences (*Comptes rendus*, vol. 176, p. 496, 1923) Urbain discusses the same problem and still claims the identity of his celtium with our hafnium and by a claim of priority rejects the latter name. In the meantime, through the investigation of Hansen and Werner (see Nature of March 10, p. 322, and the above letter in this issue) on the optical spectrum of hafnium and on the spectrum ascribed by Urbain to celtium, new data have been brought to light, and we should therefore be glad to take the opportunity to complete our arguments as regards the questions discussed by Urbain.

To put the matter clearly we must go back to the time preceding the announcement of the discovery of celtium. As is well known, Marignac succeeded in 1878 in isolating from a mineral from Ytterby a substance which was considered to be a new element and called ytterbium. In 1905 Auer von Welsbach (*Wiener Anzeiger*, x., 1905; see also *Sitzungsberichte* 115, July 1906, and *Lieb. Ann.* 351, p. 464, 1907) announced the discovery that this substance was a mixture of two elements, for which he later proposed the names aldebaranium and cassiopeium. Detailed information with regard to the spectra of these elements and their atomic weights was first published by him in 1907 (*Wiener Sitzungsberichte*, 116, December 1907), shortly after a similar announcement had been made by Urbain (*Comptes rendus*, 145, p. 759, 1907), who was the first to publish lists of lines for the separate spectra of the two new elements, and proposed the names neo-ytterbium and lutetium. By continued purification of his preparations, Urbain observed in the following years a gradual change in the spectrum and magnetic properties and announced in 1911 (*Comptes rendus*, 152, p. 141) the detection of a further element, which was called celtium, for which a separate list of spectral lines was published.

Through the work of Hansen and Werner referred to above, it is clear, however, that the latter lines are due not to a new element but to the element which was called lutetium by Urbain and cassiopeium by Auer von Welsbach, in the spectrum of preparations of which the same lines were also observed by Eder in 1915. To this we may add that the same view is supported in a striking way by investigations on the magnetic properties of the various preparations. The circumstance that the paramagnetism of Urbain's preparations of 1911 was three or four times smaller than that of his former preparations need not be explained as due to the presence of a new element, but may be considered as a consequence of the gradual concentration of the element cassiopeium or lutetium in his preparations. Thus Stephan Meyer (*Wiener Sitzungsberichte*, 117, p. 955, 1908) in his investigations of the magnetic properties of the rare earths had already found in 1908 for the paramagnetism of a cassiopeium preparation a value almost as small as that measured in 1911 by Urbain for the preparation which was believed to contain the largest percentage of celtium.

In view of the conclusion drawn by Hansen and Werner as regards the optical spectrum, this circumstance may be taken as a proof that the original preparations of Urbain from 1907 (*Comptes rendus*, 145, p. 759) contained only a rather small fraction of the element cassiopeium or lutetium and presumably much less than the preparations of Auer von Welsbach of the same time. In this connexion it is of interest to mention that, according to the quantum theory of atomic structure, the element of atomic number 71 must be assumed to be diamagnetic in its trivalent chemical compounds. In fact the absence of paramagnetism of such compounds is a necessary consequence of the theoretical conclusion that in the triply charged ions of the element 71 we first meet with a completed electronic configuration of four quantum orbits. (See N. Bohr, "Theory of Spectra and Atomic Constitution," pp. 106, 114, Cambridge University Press, 1922.) It was this conclusion which led to the anticipation verified by our discovery of hafnium, that the element 72 should not have properties analogous to the rare earths, but be a homologue of zirconium.

As will appear from the above, the existence of an element with the properties ascribed to celtium cannot be maintained, and we think ourselves justified in concluding that the important problem of the nature of the element 72 may be considered as settled by the discovery of hafnium and the investigation of its properties. While thus the general conclusions of Dauvillier and Urbain must be rejected, there remains the question, of secondary importance, whether the two extremely faint X-ray lines observed by Dauvillier in Urbain's preparation, which was believed to contain celtium, can have been due to a contamination of this preparation by a trace of hafnium. In the discussion of this point it must be emphasised, in the first place, that Urbain, in the course of his purification, made all possible precautions to remove elements other than the rare earths from his preparations. In fact, in his note in *Comptes rendus*, 1911, quoted above, M. Urbain states that "des impuretés de toutes sortes, provenant soit des vases, soit des réactifs, s'accumulèrent nécessairement dans des eaux mères successives. J'ai fait différents traitements de ces eaux mères par l'hydrogéne sulfuré, l'ammoniaque et l'acide oxalique, de manière à éliminer tout ce qui dans cette substance n'appartenait pas au groupe des terres rares. J'ai examiné ensuite la terre purifiée et parfaitement blanche." Now our investigations of the chemical properties of hafnium have shown that this element, just like zirconium, can be separated easily from the rare earth elements by a treatment with oxalic acid.

Only two lines of the element 72 were claimed to have been detected by Dauvillier, and even in the case of the most intense of these lines we meet with the difficulty that it falls in the same place in the spectrum as the strongest zirconium line in the second order. As an argument against ascribing this line to zirconium, Urbain states that the optical spectrum of his preparations did not show any zirconium line. An investigation of Urbain's spectrum of the "celtium" preparation, however, does not show any line of the hafnium spectrum (see Hansen and Werner, Nature, March 10, 1923) either. If the possibility of the presence of one of these elements in Urbain's preparation can be taken seriously into consideration, it should be expected that zirconium would be present in greater amount. In fact, zirconium was likely to be more abundant in the original mineral than hafnium, and a purification of rare earth preparations from zirconium and not simultaneously from hafnium, by treating with oxalic acid or any other method mentioned by Urbain, is scarcely imaginable in view of the close similarity of the chemical properties of these elements. As mentioned in our previous letters, however, the two lines ascribed by Dauvillier to the element 72 were lying 4 X-units distant from our Hf-lines, which is distinctly more than the limit of experimental error,[1] whereas the lines of the elements 70 and 71 measured by Dauvillier (*Comptes rendus*, vol. 174, p. 1347, 1922) on the same plates closely agree with the measurements of the same elements obtained by Coster (*Phil. Mag.*, vol. 44, p. 546, 1922). As the two lines according to Dauvillier were extremely faint, they may easily be explained to be of some other origin.

It is of interest to note that, at various times, announcements have been made as to the complexity of zirconium. In 1845 Svanberg claimed that in decomposing zircons he discovered a new element "norium," with a lower atomic weight than zirconium. His and Sjögren's (1853) statements were later disproved by the work of several investigators including Marignac. In 1864 Nylander reported the existence of two earths in zirconia. Five years later, by a spectroscopic investigation of zirconium, Sorby was led to announce the discovery of "jargonium" and Church of "nigrium." Finally, in 1901 Hofmann and Prandtl thought that they had found in euxenite a new element related to zirconium. It is also interesting to note that Mendeleéff, as we learn from Sir T. E. Thorpe's letter in NATURE of February 24, p. 252 (March 17), suggested that the extraordinarily discordant values for the atomic weight of titanium, found by several chemists, might be due to the presence of a homologous element of higher atomic weight in their material. Whether these statements in some cases may be explained by the presence of hafnium in the minerals and preparations under investigation, it is not easy to decide. The intricate chemistry of zirconium, and the great chemical similarity of hafnium with this element, would in fact have made any establishment of hafnium very difficult before the development of the powerful method of X-ray analysis.

D. COSTER.
G. HEVESY.
Universitetets Institut for teoretisk Fysik,
Copenhagen, March 20.

Constitution of Black Maketu Sand.

THE letter of Messrs. Smithells and Goucher in NATURE of March 24, p. 397, under the above title calls for a short reply from me.

The authors do not state with what object their experiments were made, but the results of these differ so much from my own as to suggest that the sand examined by them was from another part of the deposit at Maketu, or possibly from an entirely different source, such as that on the Taranaki Coast.

Is "Prof. Bohr's conclusion that no new element is present" to be found in any paper published by him? If not, it would be interesting to know upon what authority the authors quote it.

As my original communication on this subject was made to the Chemical Society, I feel it my duty to send to the Society, in the first place, the results of my own further experiments and also those of the examination of my preparations by Drs. Coster and Hevesy. This I hope to be able to do in time for publication in the Society's Journal for April.

ALEXANDER SCOTT.
34 Upper Hamilton Terrace, London, N.W.8,
March 26.

[1] Dauvillier's measurements carried out since the announcement of our discovery, on other material which possibly contained hafnium, have already led him to give new values for the same wave-lengths, which are respectively 3·4 and 2·3 X-units larger (NATURE, February 17, 1923)

Tracks of α-Particles in Helium.

IN a recent issue of NATURE (January 27, p. 114), Messrs. Ryan and Harkins have published some photographs of the ionisation tracks of recoiling atoms produced by collision of α-particles with air molecules. We have been also engaged in photographing the tracks of α-particles from polonium in helium, and have obtained some interesting photographs. Besides the long range recoil helium atoms, we have obtained a few photographs in which are shown the ionisation tracks of all the constituent parts of a helium atom, namely, of the nucleus and the two bound electrons. They are shown in Fig. 1 (i and ii).

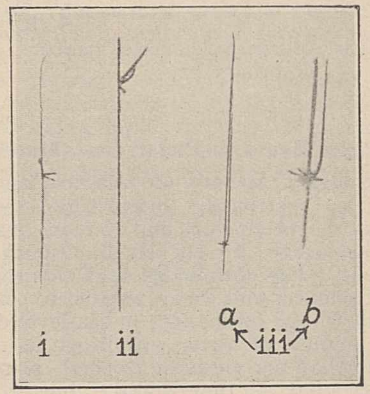

FIG. 1.

It will be noticed that both the electrons are ejected on the same side of the α-particle track. One of us (D. Bose, *Zeit. f. Phys.*, 12, 207, 1922) has previously photographed the ionisation tracks of several thousands of α-particles in hydrogen, and in no case was a photograph obtained which showed simultaneously the ionisation tracks of the two constituents of a hydrogen atom. This behaviour can well be explained on the model of the normal helium atom proposed by Lande and others, according to which the two electrons move in orbits which are inclined to one another. If an α-particle strikes the atom at the moment when both the electrons are near the point where their orbits cross, then the probability of their both being ejected in the same direction is very great.

The photograph (Fig. 1, iii, *a*) presents some special points of interest. In it is shown (1) the track of the α-particle before and after collision, (2) that of a recoiling nucleus, (3) four small tracks which radiate out from the circular patch and are due to the electrons which are ejected from the atom under collision. The circular patch, which is absent in the photographs of other recoiling atoms, resolves when seen under high magnification into a number of lines radiating from a centre. An enlarged photograph which has been slightly retouched is reproduced in (iii, *b*). It will be noticed also that the path of the recoil atom is very much curved in the beginning—a phenomenon we have not observed before in the many tracks of the recoil atoms which we have obtained in air, hydrogen, and helium. Its length is 4 cm., and is larger than any of the other recoiling atom tracks which we have obtained in helium.

Judging from the number of the electrons which have been emitted we have here evidently the collision of an α-particle with an atom more complex than either hydrogen or helium; we can suppose it to be either nitrogen or oxygen; such atoms can well be expected to be present as impurities. But it is difficult to conceive how a recoiling atom of mass 14 or 16 can produce an ionisation track of 4 cm. length in a mixture of helium and water vapour, after suffering a collision with an α-particle from polonium. The distance at which the collision took place was about 3 cm. from the source. Probably the phenomena observed can best be explained on the assumption that here we have the case of the breaking up of a nitrogen nucleus by an α-particle with the expulsion of a hydrogen nucleus, which produces the long ionisation path. The cause of the large initial curvature of the path remains to be explained. It is not due to the superposition of a number of large-angled single scatterings.

Further experiments are in progress.

D. M. BOSE.
S. K. GHOSH.
University College of Science, Calcutta,
February 21.

Porto Santo in Pleistocene Times.

THE Geological Society of America has recently published an extremely interesting review and summary of the recent work and opinions of specialists on the Pleistocene, by Dr. H. F. Osborn and Dr. C. A. Reeds. The chronology and changes of level are fully discussed, and we are invited to consider the evidence in favour of changes in sea-level depending upon the amount of water withdrawn as ice. It is improbable that the views of Depéret, in particular, will be accepted as they stand; but it must be admitted that the glacial periods produced some world-wide changes of level, and the question how great these were becomes an extremely interesting one.

The statement of these views is an invitation to geologists all over the world to search their coasts anew, and try to detect evidence of the postulated phenomena. In the course of this search I believe few places will better repay study than Porto Santo, in the Madeira group. I have on more than one occasion directed attention to the small I. de Cima, separated from the main island by a narrow and shallow channel (Boqueirao de Cima), yet possessing a very distinct species of snail in great abundance, found nowhere else. The postulated fall of the sea in glacial times would, I think, certainly unite Cima with the main island, yet the snail has not passed. That the snail has evolved in post-glacial times seems improbable. Between Cima and the main island are some rocks, and on one of these (Sircada) Miss Nancy Paterson collected for me some fossil snails, *Ochthephila obtecta* and others. I thought at first that we had evidence of a submerged island or neck of land between Porto Santo and Cima, once supporting a snail-fauna, but now washed by the waves. Further investigation, however, convinced me that the Sircada Rock was nothing more than a large piece of the adjacent high cliff of the main island, which had fallen into the sea, carrying the fossils with it. Objection may be made that in postulating long constancy of level for the islets Cima and Baixo I do not take into account denudation, which would have worn them down had they not risen (or the sea fallen). These islets are essentially flat on the top, and wear away extremely slowly above, but rapidly along the sides, so that we have what may be called *lateral denudation*. This can be seen going on at the present time.

Continuing the investigation, we naturally ask for marine pleistocene beds. These are to be found at the Campo do Baixo, west of the Villa Baleira on the main island. A wide well has been dug at this place, and it is possible to go down and explore it fully. At a depth of about 30 feet is a layer of marine pleistocene rock, full of shells firmly cemented together. This rests on dense, dark, volcanic rock, but there is no evidence of volcanic activity in the material above. Far above the marine bed, near the surface, is dense sandy rock containing snail shells, *Plebecula bowditchiana* (Fér.), *Ochthephila tectiformis* (Sby.), etc. *P. bowditchiana* is an extinct species, but it is not certain that it lived so much later than the marine beds, for it might have been carried in shifting sand, though it is a heavy shell to travel in that manner. Another species of snail, *Ochthephila coronata* (Desh.), was found in the marine layer itself. A fine slab of the marine deposit, carrying many shells, has been presented to the British Museum. I broke up a quantity of the material, and submitted a series of the shells to Mr. J. R. le B. Tomlin, who has very kindly determined them as follows: *Erato prayensis* Rochebrune, *Mitra fusca* Swainson, *Cerithium vulgatum* Brug., *Bittium latreillei* Payr., (abundant), *Alectrion incrassata* Müll., *Trivia pulex* Sol., *Rissoa costulata* Ald., *Alvania testæ* Ar. and Magg., *A. punctura* Mont.(?), *Mangilia striolata* Sc., *Natica* sp. (? *macilenta* Phil., or perhaps *sanctæ-helenæ* Smith), *Anadema cœlatum* A. Ad. (?), *Calliostoma exasperatum* Penn., *Cardium papillosum* Poli, *C. tuberculatum* L., *Ervilia castanea* Mont., *Macrocallista chione* L. To these I may add the common *Columbella rustica* L., which was not submitted to Mr. Tomlin. A peculiar Naticoid and some others were not determined.

This is a modern fauna, many of the species still abundant in the sea near by. The place is not far from the sea, a short distance behind the line of sand hills, which are planted with tamarisk. The level of the deposit is little if at all below that of the shore, and we are not obliged to postulate anything more than a deeper bay, now largely filled up with sand.

This brief discussion merely opens up the subject, and it is to be hoped that some student will pursue the matter further, combining a charming holiday with profitable research. T. D. A. COCKERELL.

University of Colorado,
Boulder,
February 21.

The Hermit-Crab and the Anemone.

IN NATURE of December 2 and 30, 1922, vol. 110 (pp. 735 and 877), there are two very interesting letters from Dr. J. H. Orton on the relationship between these animals and the advantages of the partnership. Many years ago (September 1901) I took the opportunity, after a short visit to Millport, to watch the habits of the species *Eupagurus prideauxii* and *Adamsia palliata*, which seem always to live together, the association presumably being needful for their mutual welfare. Possibly my observations of these may be helpful in understanding the ways of other Paguridæ.

On the occasion referred to, I brought with me to Sheffield a specimen of the hermit-crab and Adamsia living together. To ensure their being undisturbed during my experiments, they were settled by themselves in a small aquarium and regularly fed with oysters and cockles. I thus managed to keep them alive and healthy for nearly six weeks. The Adamsia, as is usual, had attached itself head downwards on the underside of the shell occupied by the hermit-crab, and the two sides of its base had grown upwards and round the shell, so as to meet in the centre above the back of the crab, forming a tube or sack for its accommodation, the crab having far outgrown the small Natica-shell, which, later, was found at the bottom of the sack.

Matters had thus been arranged between the two animals so that, as is well known, the head of Adamsia hung downwards and its tentacles, brushlike, were carried over the surface of the sand when the hermit-crab travelled from place to place. The first two pairs of the long, slender walking legs of the hermit-crab were directed backwards in a manner which suggested protection of the anemone, but this appearance was misleading, as it was soon found that their function, in addition to that of locomotion, was to steal the food collected by the anemone. This was effected most cleverly by an underneath upwards sweep of the leg, the terminal portion of which passed through the tentacles of the anemone and carried any food found therein swiftly to the mouth of the hermit-crab. It is interesting to note that these limbs seem specially adapted to this purpose. The part mentioned (the dactyl) in this species (*E. prideauxii*) is long and very slender, and its inner or concave side is beset with a row of many long fine hairs projecting inwards like the bristles of a brush, thus forming a very effective instrument for sweeping out the mouth of the Adamsia. At times, also, the claws were doubled under the hermit-crab's body and seized the food which had been secured by the anemone. At first food was supplied for the joint use of the animals. Later on I experimented and tried to *feed* the *anemone alone*, but in this I never succeeded, as although the hermit-crab could not see the food, it was so instantly detected and swiftly swept away, as described, that one wondered how the anemone ever got sufficient for its own needs. Whether some sensory hairs on the dactylopodite had anything to do with detection I cannot say.

My observations seem to show that, though both animals benefit, the advantages of the partnership in this particular case are very largely on the side of the hermit-crab, which, in addition to being supplied with food, may possibly derive some benefit from the Adamsia's power when irritated, of firing a broadside of stinging threads through the numerous portholes in its sides. So far as I can see at present, the only profit to the Adamsia is that of being carried from place to place, and thus afforded a better chance of securing food, for which, as has often been pointed out, the downward direction of the mouth and tentacles is most favourable. The anemone may, of course, derive other advantages which are less obvious, and the parallel case (to which Dr. Orton has directed attention) of the little tropical crab, *Melia tessellata*, which carries in each claw a living sea anemone and uses it as a weapon and also (like Adamsia) as a collector of food, suggests the possibility.

On the face of it, Adamsia and the little anemones first mentioned seem to be the willing slaves of the hermit-crabs, for P. H. Gosse's observation, in 1859, of how *E. prideauxii* with its claws transferred the Adamsia from its old shell to a new one ("A Year at the Shore," pp. 241-247), which was later confirmed by Col. Stuart Wortley (*Ann. and Mag. Nat. Hist.*, 1863, p. 388), seems to show that the hermit-crab is the keenly interested active agent in arranging matters so advantageously for itself. With the common hermit-crab (*E. bernhardus*) and *Sagartia parasitica*, however, matters are reversed. Here the anemone evidently takes the initiative, and except perhaps by the camouflage, etc., which is afforded by its riding on the whelk-shell occupied by the hermit-crab, the latter appears to derive no benefit. The position assumed by the anemone is unfavourable to the hermit-crab's sharing in its captures; moreover, the walking legs of the hermit-crab are not adapted to securing a portion, the concave side of the dactyl of *E. bernhardus* being smooth and practically free from hairs, whilst the limb is otherwise unsuitable for the purpose. It seems as though *S. parasitica* has taken a hint from Adamsia and improved upon it.

ARNOLD T. WATSON.

Southwold, Tapton Crescent Road,
Sheffield, March 15.

Paradoxical Rainfall Data.

PROF. McADIE, in NATURE of March 17, p. 362, directs attention to the apparently paradoxical fact that the wettest month observed in 37 years at Blue Hill observatory fell in June, the month with the lowest rainfall average, whereas the driest month fell in March, the month with the highest average. The coincidence is a curious one, but less improbable than might at first sight appear, since the monthly rainfall is at many stations extremely variable. Some idea of its extreme variability may be gathered from the following table, showing the distribution in half-inch intervals of the rainfall at Rothamsted for 70 years from March 1853 to February 1923.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
0–·5		4	1	5	1	3	5		1		1	2	23
·5–1·0	9	11	11	8	7	9	5	4	5	4	4	6	83
1·0–1·5	12½	19	13	12	18	10	11	13	13	7	11	9	148½
1·5–2·0	7½	10	16	14	12	13	7	7	11	14	4	14	129½
2·0–2·5	10	8	10	10	12	6½	11	8	17	5	18	7	122½
2·5–3·0	9	4	7	12	8	10½	5	13	7	11	11	6	103½
3·0–3·5	7	5	4	3	5	5	9	9	6	6	6	10	75
3·5–4·0	9	6	4	3	1	5	2	7	2	5	4	3	51
4·0–4·5	4	1	3	1	3	2	5	3	3	4	7	6	42
4·5–5·0	2	2	1	2	2½	3	5	2	1	3	3	1	27½
5·0–5·5					½		2		2	3	1	1	9½
5·5–6·0						1	2	1	1	4		2	11
6·0–6·5						2				1		2	5
6·5–7·0							1	3		2			6
7·0–7·5										1			1
7·5–8·0													
8·0–8·5									1			1	2
	70	70	70	70	70	70	70	70	70	70	70	70	840

The seasonal effect appears to be more strongly marked at Rothamsted, where the mean rainfall (per day) in October is about 54 per cent. greater than that in April, than it is at Blue Hill, where the mean rainfall (per day) in February is only about 24 per cent. more than in June. Nevertheless, even in the Rothamsted data, the variability of rainfall in the same calendar month is so great that the mean values give little or no indication as to which month should be expected to score a record for rain or drought. Indeed, both records are at present held by December, which in 1864 gave one-sixteenth of an inch of rain (0·063), and in 1914 gave 8·103 inches.

R. A. FISHER.

Rothamsted Experimental Station,
Harpenden, Herts.

Rothamsted and Agricultural Science.[1]

By Sir JOHN RUSSELL, F.R.S.

THE Rothamsted Experimental Station has just passed its eightieth year, having been founded in 1843. Its study has always been the growth of crops, with periodical excursions into problems of utilisation; the method of experiment has always been essentially statistical in that the field experiments were repeated year after year without modification, with the result that a unique mass of data has now accumulated which is proving of the greatest value for statistical investigation.

The work at Rothamsted falls into two great periods: the first, when Lawes and Gilbert were actively exploring the possibilities opened up by the knowledge of plant nutrition gained by the early nineteenth-century workers; and the more recent period, when close study of the soil has revealed certain factors of high scientific interest, and, one is constrained to believe, ultimately of great practical importance.

The great problem which Lawes and Gilbert set out to solve was to account for the fertilising value of farmyard manure. The fact was well known, but there was no satisfactory explanation. Lawes and Gilbert proceeded by a method that still—after eighty years—remains our best. It was known that farmyard manure contained three groups of components: organic matter; nitrogen compounds; and ash constituents—potassium, calcium and magnesium salts, phosphates, silicates, etc. They therefore arranged vegetation tests with these various groups. The old idea was that the fertilising value lay in the organic matter, but Liebig, in 1840, had argued brilliantly against this view, and suggested instead that the ash constituents, especially the potassium, calcium and magnesium salts, were the effective agents. Lawes and Gilbert were prepared to recognise the necessity for these mineral salts, but insisted that the nitrogen compounds were equally required. To put the matter to a test, they laid out four plots of ground, receiving respectively no manure, farmyard manure, ashes of an equal amount of farmyard manure, and these ashes plus a nitrogen compound (ammonium sulphate). The results were as follows:

PRODUCE OF WHEAT PER ACRE, BROADBALK FIELD, ROTHAMSTED, 1844.

	Grain. (bush.)	Straw. (cwts.)
No manure	16	1120
Farmyard manure (14 tons per acre)	22	1476
Ashes of 14 tons of farmyard manure . . .	16	1104
Ash constituents + nitrogen compounds and ammonium sulphate, up to . . .	26¼	1772

They concluded that farmyard manure owes its value, not to the organic matter as was for long supposed, nor to the ash constituents as Liebig had suggested, but to the ash constituents plus nitrogen compounds.

Now this discovery was of the greatest importance in plant physiology, but Lawes and Gilbert did not follow it up in that direction. Instead they applied it at once to an important agricultural problem then ripe for solution. There was then (as nearly always now) a shortage of farmyard manure on farms, and agriculturists had for generations sought for substitutes, but with little success. Lawes and Gilbert saw that the mixture of ash constituents and nitrogen compounds would form an effective substitute, and further, that it could be obtained in very large quantities, and of course independently of farmyard manure. Geologists had discovered vast deposits of calcium phosphate, which chemists had shown how to render soluble. Engineers were developing the manufacture of coal gas and producing large quantities of ammonium sulphate, while potassium compounds could be obtained without difficulty from wood ashes. Lawes and Gilbert therefore proceeded to make mixtures of these substances which they advised farmers to use.

Few experiments have proved so fruitful in stimulating scientific inquiry—it is still opening up new fields at Rothamsted—and in ministering to human needs, as this simple field trial carried out eighty years ago on the Broadbalk field at Rothamsted. At first farmers looked with some misgiving upon this new kind of manure (which was called "artificial manure" to distinguish it from farmyard manure, then known as "natural manure"); it seemed incredible that a harmless-looking powder without smell or taste could act as potently as the old-time richly odorous farmyard manure. But they soon came to recognise its value, and before long they were using many thousands of tons a year. It is safe to say that the remarkable development of British agriculture which took place between 1843, when Rothamsted began, and 1870, would have been impossible without artificial fertilisers. During that period British farmers kept pace with the growing needs of the population; indeed they did more, for they helped to change the "hungry 'forties" into the more plentiful 'seventies. The use of artificial fertilisers is now developed throughout the civilised world and the industry has attained enormous dimensions.

This was the greatest achievement of Lawes and Gilbert. They did many other things for the farmers of their day, but this alone leaves us owing them a great debt of gratitude.

As the use of artificial fertilisers spread there arose, as one might expect, many problems of great scientific interest or technical importance. Thus it soon appeared that weather conditions profoundly affected the response of crops to artificial fertilisers. The same fertiliser mixture which in one season gave results fully equal to, or even surpassing those of farmyard manure, would, on the same farm and even in the same field, prove a failure in another season. This is well shown in the fluctuations in yield on the Broadbalk wheat field at Rothamsted.

The effect of soil is also sharply marked. On our heavy soil at Rothamsted the best results are usually obtained by a fairly liberal use of phosphates, but there is less necessity for large dressings of potash. But on the much lighter soil of Woburn potash is considerably more important, while phosphates

[1] Discourse delivered at the Royal Institution on Friday, February 9.

are less needed, and, indeed, beyond a certain quantity appear to do actual harm. It is obvious, therefore, that a complete manure drawn up on the basis of the Rothamsted experiments would fail in practice to give the best results on a lighter soil. As an instance the following may be quoted, this being one of a general scheme of experiments organised from Rothamsted:

BARLEY: LIGHT SANDY SOIL IN SUFFOLK, 1922.

	Bush. per acre.
Complete artificial manure	21·5
Incomplete manure: phosphate omitted	27·5
No manure	16·0

In this instance the omission of phosphates has raised the yield by 6 bushels per acre. As against this, an array of instances might be brought from clay farms where a phosphate is the one and only thing that causes crop increases. Any one who had to deal with

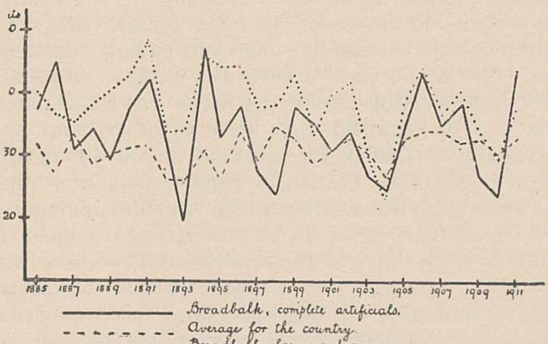

FIG. 1.—Yields of wheat from Broadbalk plots manured with complete artificial manures, and farmyard manure, respectively, compared with the average yield for the whole country.

farmers' problems could multiply apparent contradictions and inconsistencies of this kind. When one collects, as we have done at Rothamsted, the results of field trials with artificial manures made in different parts of the country they seem at first to be simply a tangled mass of unrelated facts.

Now it is the business of the man of science to sort out a tangle of this kind, to reduce it to order, to find the general principles running through it, and finally to prove the correctness of his conclusions by being able to predict with certainty what will happen in given conditions. The recognised method of procedure is to discover the various factors at work and investigate them one at a time. This is being done at Rothamsted in two ways: by field observations, and by quantitative laboratory measurements. Observations in the field show that each of the fertilising substances—phosphates, potassium compounds, nitrogen compounds, etc.—in addition to its general effect in increasing plant growth, produces certain specific effects which may be of advantage, or may be a disadvantage to the plant in the particular conditions in which it happens to be growing. Thus, phosphates have a special influence in hastening the ripening processes, which no doubt accounts for the Suffolk results just quoted. In the dry conditions of a sandy soil, ripening is already too early, and any reduction in an already short growing season cuts down the yield; in cold, wet districts, however, this property is very valuable.

In the early stages of the plant's life phosphates stimulate root development to a marked degree; this is well shown in their effect on swedes. Nitrogen compounds tend to increase leaf development and give greater vigour of growth, but beyond a certain point the advantage is counteracted by a loss of resisting power, and the plants may fall victims to attacks of disease. Crops—especially cereals—may be unable to stand up against the weather and may become "lodged." Indeed, the proper adjustment of plant nutrients affords plant pathologists one method of dealing with plant diseases.

Qualitative observations of this kind, while of high value, are not entirely sufficient: it is necessary to have quantitative measurements of as high an order of accuracy as possible. At Rothamsted this is done by means of water cultures and pot experiments; all the factors are controlled as closely as possible and the results are plotted on curves which can be studied in detail. This method was developed extensively by Hellriegel and is now in common use in agricultural laboratories.

The method naturally invites mathematical treatment, and attempts have been made, notably by Mitscherlich, to express the curve by equations. There is a seductive look about a mathematical formula which rarely fails to appeal to the biologist, but as a rule the number of experimental points obtained is much too small to justify mathematical treatment, and it is not surprising that investigators fail to agree. Ten years ago the fashion was for logarithmic curves; now it is for sigmoid curves, which are probably nearer the truth, though not yet a complete expression.

This method of studying single factors is pushed to a high degree of refinement in plant physiology laboratories, such as that of the Imperial College under Prof. Blackman, or that under his brother at Cambridge, and there can be little doubt that the effect of individual factors on the plant will ultimately be well known. All this work is giving valuable information as to causes and principles.

These curves show the relationship between yield and plant food supply at one particular temperature which remains constant, and one particular water supply which also remains constant. But a completely different set of figures would be obtained if the temperature were different or if the water supply were altered. Supposing one wished to take account of the effect of water supply as well as food, one would draw a series of curves, which would properly be expressed as a surface, and this has been done by one of the Rothamsted workers—Mr. J. A. Prescott—to show the effect of nitrate supply and spacing on the yield of maize in Egypt. The experiments had the advantage that the climatic conditions are less fickle there than here. It would be of the greatest interest to obtain such surfaces for other pairs of factors.

If an attempt were made to study factors three at a time, it would be necessary to prepare a series of surfaces and to embody them in a figure in four dimensions, which is certainly beyond the capacity of the ordinary agricultural investigator. But in agricultural field work the factors do not vary one at the time, or even two or three at the time; there may be half-a-dozen variables. This, of course, enormously complicates any attempt to apply to field conditions the results obtained by these single factor physiological experiments. It is possible that when the physiologists have completely elucidated all the single factors, some one will be able to synthesise the material and build it into some great conception or expression that will contain all, and thus account for the field results. But history shows that the genius capable of effecting a synthesis of this sort is very rare and might have to be awaited long.

We have therefore adopted another method at Rothamsted, which is being worked alongside of the single factor method. Statisticians have, during recent years, been evolving methods for dealing with cases where several factors vary simultaneously. These methods have been applied by Mr. R. A. Fisher to the Rothamsted field data, and he has been able to trace

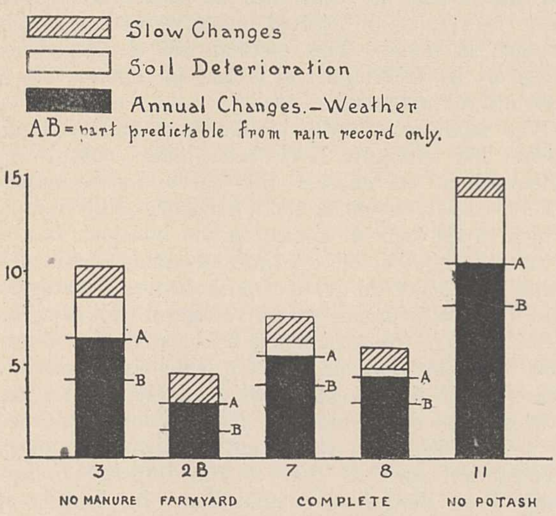

Fig. 2.—Mr. R. A. Fisher's results showing amounts of predictable variation in wheat yields, Broadbalk, Rothamsted.

certain statistical regularities which foreshadow the possibility of important developments.

Thus, the yields on the Broadbalk wheat field vary every year, apparently in a most erratic manner. But analysis of the figures showed that the factors causing variation could be disentangled and expressed quantitatively; there are slow changes in the field, such as changes in the amount of weeds, etc.; deterioration of soil; and weather changes such as rainfall, temperature, etc. (Fig. 2).

As might be expected, the effects differ according to manurial conditions; *e.g.* the influence of weather varies with the manure. Important differences appear between farmyard manure and artificials. The variation in yield is less where farmyard manure is given than where artificials are used. Further, the so-called complete manure appears not really complete at all; there is soil deterioration going on; but with farmyard manure no such deterioration is produced. The different kinds and quantities of artificial manures produce different effects on the variation in yield, the magnitude of which has been worked out.

Having disentangled the factors Mr. Fisher has proceeded to analyse the effect of rainfall, and he finds that part of the weather effect is predictable when rainfall is known. Rain above the average in autumn is somewhat beneficial; in winter and in summer it is harmful, and in spring it is less frequently harmful. As before, the effects are much more pronounced with complete artificials than with farmyard manure. The actual facts have long been known in a general way, but here is an exact quantitative measurement.

The great advantage of this statistical regularity is that it indicates the possibility of expressing in terms of chance the influence of the weather, soil, etc., on crop yields. We hope ultimately to be able to say to the farmer, given such and such conditions of soil and weather, the chances are so many to one that such and such an increase of yield will be obtained by the use of a specified fertiliser. The expression would be understood by every farmer, and he would readily decide whether to take the risk or not.

Much greater results would also follow. At present the farmer cannot cover his risks of low yields by insurance, the companies not yet having sufficient data. We hope and believe that these statistical investigations will afford the basis on which such data will be obtained. At present the position approximates to that of life insurance in the eighteenth century, when the statistical regularity of mortality was first established, after which the first life tables could be constructed. There still remains a mass of detail to work out, but the fundamental problems are now being attacked, and we see no reason to regard them as insoluble. If the expectancy of crop yields proves to be calculable the farmer will be able to insure himself against crop failure, and so meet one of the worst vicissitudes of his troubled life by merely taking out an insurance policy—perhaps even by subscribing to a particular newspaper.

We are constrained to admit that the work is still far from completion, and in the meantime agriculture has fallen on difficult days and farmers are turning to us to ask how they can obtain large crops in the most economical way. It is not general principles they want, but particular instructions.

We are not in a position to give an absolute clear-cut prescription to any farmer, but we are going a long way to meet him. Some of our field experiments of special interest or importance are being repeated at other centres where soil and climatic conditions are all different. The results are compared with ours, or with others that have been obtained, to ascertain how far or in what direction any of our conclusions would need modification in a particular district.

We now return to an important result to which I have already referred. Over a period of years the artificial manures have not proved quite as effective as farmyard manure; there has been more variation in yield and they have not so well maintained the fertility of the soil as farmyard manure has done. On some crops the effect is marked; clover responds better to farmyard manure than to artificials. It appears then that Lawes' and Gilbert's views that the fertiliser value of farmyard manure lay in its ash constituents plus nitrogen compounds is only a first approximation, and that farmyard manure does something or contains something which artificial manures do not. This difference we are now engaged in exploring.

The same method of procedure is used as in studying the effects of artificial fertilisers. A full scientific investigation into the causes is carried out, but simultaneously an attempt is made to find some working solution of the farmers' problems. The shortage of farmyard manure is still as acute as ever, and to keep more animals with the view of making more is uneconomic. At Rothamsted we have attempted to produce farmyard manure from straw artificially and without animals. This has been done by Mr. E. H. Richards and Dr. Hutchison by simulating the essentials of the natural process, namely, watering straw with a salt of ammonia (actually ammonium sulphate, but calcium carbonate is mixed with the straw), and leaving the heap so that the air can get in and the organisms can do their work. The product is not yet equal to the natural substance, but it is steadily being improved, and the very serious difficulties are gradually disappearing in Mr. Richards's competent hands. Five years ago a few ounces only of this artificial farmyard manure had been prepared; last year several thousand tons were made on various farms in different parts of the country, and the news is spreading. The serious problem of developing the work from the laboratory to the farm scale has been possible through the generous and public-spirited action of Lord Elveden. There seems here the possibility of aid to the farmer and of the development of an important new industry.

Meanwhile a full scientific investigation is being carried on to discover wherein farmyard manure differs from artificials. One important difference is already known and is being investigated by Dr. Keen. Farmyard manure opens out the soil particles leaving bigger pore spaces; it allows of the retention of more moisture and the better circulation of air. All these effects are beneficial.

There is also another difference. Farmyard manure and also plant residues (which are substantially the same thing) decompose in the soil, giving rise to many substances of different types. The plant foods are among the end products: indeed, in natural conditions, and, to a large extent, in farms and gardens also, it is in this way that plants obtain their food. In using artificial manures we supply these end products at once instead of waiting for them to be liberated gradually by the natural decomposition. Further, we do not by any means know the whole of the processes whereby plant food is made. But there are certain intermediate products, and it is quite possible that some of these may have a special effect on the growing plant. Curious stimulating effects are produced by substances formed when soil is steamed, or when oxidation is accelerated by addition of charcoal, and we have obtained the same results with small quantities of picric acid; such bodies might well be formed as intermediates in the decomposition of farmyard manure. The whole effect suggests an action like that of the vitamins of plant physiologists or the auximones of the late Prof. Bottomley. The chemical department at Rothamsted, under Mr. Page, is following out the process, and the botanical department, under Dr. Winifred Brenchley, will test any intermediate products which may be obtained.

A further important factor, which probably governs the whole situation, is that a great part of the process of decomposition and plant food production appears to be brought about by living organisms in the soil. Simultaneously, therefore, with the chemical and botanical investigations, the various biological departments are busily engaged in studying the organisms that are doing the work.

It is a wonderful story that is being revealed. The soil is shown to be the abode of a vast population of living organisms of the most varied kind. Some of them are remarkably small; among them one which brings about the last stage in the formation of nitrates —an organism which Rothamsted just missed forty years ago: another, also just missed at Rothamsted, which has the remarkable property of fixing nitrogen in the nodule of the clover plant. Others are larger and more easily picked out, but their exact place in the soil economy is not easy to determine: probably they are concerned in the preliminary stages of the decomposition.

It is impossible to peer into the soil with a microscope, so that indirect methods of exploration have to be used. At Rothamsted the organisms are counted and the work they do is estimated by some chemical process: virtually we take a census of population and production in the soil. Like other census methods, it is comparative only: a single census is not much use; it is not until several have been taken that one can find how the numbers and activities of the population are being affected by various conditions. The census is therefore repeated periodically and the results plotted on curves from which it is possible to deduce the effect of various factors on the particular organisms counted.

These curves brought out the remarkable result that partial sterilisation increased bacterial activity, and investigation showed that the normal virgin soil must contain other organisms besides bacteria—organisms, moreover, which were detrimental to bacteria and tended to keep their numbers down. A search for such organisms showed that protozoa were present: many forms have since been found in the soil, some of which are known to feed on bacteria. Mr. Cutler has discovered how to count them, and with the co-operation of willing workers has succeeded in carrying out perhaps the most remarkable census yet made of the bacterial and protozoan population of a natural field soil. Before the census began many months were spent in perfecting the methods and technique, and in making preliminary studies of the soil. The details were carefully arranged with the statistical department, and it was decided to take the census many times at short intervals. Time to a bacillus or a protozoan is a different thing from what it is to us, and instead of taking the census every ten years, or even every ten days, it was taken daily, and at the same hour every day. Many repetitions were needed so that the statistician might feel safe in drawing conclusions from the data. The census was therefore made every day for 365 consecutive days, and no less than seventeen different organisms were enumerated.

A team of five workers kept the investigation going without intermission—Sundays, Bank Holidays, and Christmas Day—for a whole year. A mass of data was obtained of high statistical value which is proving of the greatest importance in the study of the soil population. One of the most interesting results was the proof that the soil population is not steady in number as had always been assumed, but is in a violent state of flux. Every organism observed—protozoon or bacterium—showed great daily variations, which seemed to be independent of external conditions. At least one showed a two-day periodicity. The fluctuations of the amœbæ were of special interest as they were exactly the reverse of the bacterial fluctuations. Close examination of the curves leaves no doubt that the fluctuations of the amœbæ cause the fluctuations of the bacteria, high numbers of amœbæ causing low numbers of bacteria, and low numbers of amœbæ allowing bacterial numbers to rise: but why the amœbæ fluctuate remains a mystery.

In the case of bacteria it has been possible to make even closer observations. A census organised by Messrs. Thornton and Page has been taken each two hours for several days and nights; but again the same wonderful fluctuations are seen. As might be expected, the amount of work, as measured by the nitrate present, alters from hour to hour. But the curve was not quite what was expected: the increases in amount of nitrate could be understood as representing the work done by bacteria, but the decreases were more difficult to explain. There was no rain to wash it out and there were no plants to take it up; yet the nitrate tends to disappear. The results suggest that some organism is absorbing it. Algæ and fungi could both do this, and both are found in the soil: Dr. Muriel Bristol and Dr. Brierley are closely studying them.

Perhaps even more remarkable than the daily changes are the great seasonal changes. It appears that the whole soil population is depressed in winter and in summer, and is uplifted in spring and autumn. How this comes about we do not know. The phenomenon does not seem to be confined to the soil; the algæ in a pond and the plankton in the sea, like the organisms in the soil, all seem to feel the joy of spring; it is as if Virgil had got hold of some great truth in natural science, which we have not yet been able to express in cold scientific terms, when he says that in spring "Aether, the Almighty Father of Nature, descends upon the earth, and blending his mighty frame with hers, gives life to all the embryos within." ("Georgics," Bk. II. 11, 324-327).

The number of organisms in one single gram of soil—no more than a teaspoonful—often well exceeds 40 millions. This looks big, but it is difficult to form an idea of its immensity. If each unit in the whole array could be magnified up to the size of a man and the whole caused to march past in single file, they would go in a steady stream, every hour of the day and night for a year, a month and a day, before they had all passed. We must think then of the apparently lifeless soil which we tread beneath our feet as really throbbing with life, changing daily and hourly in obedience to some great laws which we have not yet discovered; pulsating with birth, death, decay, and new birth. And if the wonder were not sufficient, we know that in some way these lowly organisms are preparing the food for our crops—the crops on which we ourselves feed. It is possible—it is even probable—that our attempts to learn something of this wonderful population may lead to some degree of control which would have valuable economic results. But even if this never happened the work would still be justified because it shows to the countryman something of the abounding interest of his daily task and of the infinite wonder of the soil on which he spends his life.

The Present and Future of Marine Engineering.

THOUGH shipping and shipbuilding are passing through a period of severe depression it is generally considered that more prosperous times are in sight. The War, as is well known, occasioned tremendous losses to the shipping of the world—we ourselves lost over seven million tons—but this has been more than made up, and the latest edition of Lloyd's Register Book shows that there are afloat to-day, exclusive of sailing vessels and vessels under 100 tons, some 29,000 steam and motor ships of a total tonnage of 61,000,000 tons. This is an increase of some 14,000,000 tons on the figures for 1914, but while in that year the United Kingdom owned nearly 44½ per cent of the world's sea-going steam tonnage our present proportion is just over 33½ per cent. In spite of this, we are still the greatest users of ships and the greatest builders of ships, though to-day shipping returns are only too eloquent of ships laid up, berths empty, shops closed, and machinery idle.

While this is the case, the competition for such orders as are to be obtained has forced all designers to study more closely than ever the economics of shipbuilding and marine engineering, and a vast amount of investigation and research is being carried out. Especially noteworthy are the inquiries being made into the respective advantages of the steam engine, the steam turbine, and the oil engine. As a result of this, the shipowner is to-day offered a bewildering variety of machinery of various types, all of which have their respective merits. A quarter of a century ago marine machinery was more or less standardised. Practically every ship built then was fitted with cylindrical boilers burning coal, and triple expansion engines. Of the 61,000,000 tons of shipping referred to above, 51,000,000 tons are still driven by such engines. Remarkably successful as it has been, the reciprocating steam engine, however, has long been superseded in naval vessels and fast liners by the steam turbine, and now its very existence is threatened, on one hand by the turbine combined with mechanical, hydraulic, or electric transmission gear, and on the other hand by numerous forms of the Diesel internal combustion engine.

The present position of the marine steam turbine is scarcely less critical than that of the triple expansion engine. It is twenty-one years since the marine steam turbine was used commercially, and it is estimated that turbines of more than 50,000,000 horsepower have been fitted in ships. There are many types, such as those of Parsons, Curtis, Rateau, De Laval, Zoelly, and others, but it was the Parsons turbine which led the way. Originally the turbine was connected directly to the propeller shaft. To be economical, however, the turbine should run fast and the propeller slow. To achieve this object, Sir Charles Parsons introduced helical tooth gearing, the turbine shaft having a small pinion which geared into a large wheel in the propeller shaft. Such single reduction gearing was successfully tried in the s.s. *Vespasian* in 1909. Since then double reduction gearing, consisting of a train of four wheels, has been largely used. In this arrangement the pinion in the turbine shaft drives a wheel on an intermediate shaft, and a pinion in the second shaft drives the wheel in the propeller shaft. By this means it is possible to run the turbine at three or four thousand revolutions per minute while maintaining a suitable propeller speed. One of the finest examples of such gearing is found in the latest liner of the Canadian Pacific Railway Company, the *Empress of Canada*. Completed last summer, this vessel is the largest passenger ship running in the Pacific. Of 21,520 tons, she is driven by twin sets of Brown Curtis turbines, each set having H.P., 1st I.P., 2nd I.P., and L.P. turbines, which drive the propeller through double reduction gearing. The main gear wheel on the propeller shaft alone weighs 65 tons, while one complete set of gearing weighs about 200 tons. Additional interest attaches to this installation, due to the application of the principle of the nodal drive devised by Dr. J. H. Smith, of Belfast, in order to avoid trouble due to torsional oscillations of the various shafts.

But while mechanical gearing of this kind has been used extensively, there have unfortunately been serious failures which have given rise to more than a little doubt as to the trustworthiness of such gearing. The elucidation of the causes of the failures is among the most pressing problems facing the marine engineer. References to this were made in the recent presidential addresses of Engr. Vice-Admiral Sir George Goodwin, Dr. W. H. Maw, and of Prof. T. B. Abell to the Institute of Marine Engineers, the Institution of Civil Engineers, and the Liverpool Engineering Society respectively, and the urgent need for further research was pointed out. Failures occur from the wearing or the breaking of the teeth. In some instances where wear has taken place the trouble has not been serious, and with further use the condition of the gearing has improved. When fracture takes place the broken pieces sometimes fall clear of the wheels, and the damage is slight. If, however, the broken teeth are caught in the wheels distortion and crushing takes place immediately, and the gear wheels are rendered useless. The causes of failure have been variously assigned to inaccurate cutting of the teeth, want of alignment of the shafts, improper design, unsuitable or faulty material, and the occurrence of excessive torsional vibrations in the shafting and gearing. This latter subject has been dealt with recently in a valuable paper by Messrs. A. T. Thorne and J. Calderwood, read before the North-East Coast Institution of Engineers and Shipbuilders.

Recent improvements in steamships, whether driven by turbines or reciprocating engines, have been largely concerned with the stokehold. Though cylindrical boilers still remain the rule, water-tube boilers are being fitted in increasing numbers, and in such vessels as fast torpedo craft and cross Channel steamers the combination of the water-tube boiler with the geared turbine is likely to hold its own for a long time. The water-tube boiler leads to a reduction in weight, it can be forced at a high rate of combustion, and it is admirably adapted for use with oil fuel. Naval vessels have used water-tube boilers exclusively for many years, but it is only recently the mercantile marine have taken kindly to them. The most notable example of the use of water-tube boilers in a merchant ship is found in the White Star liner, the *Majestic*, the ex-German ship *Bismarck*, which it is anticipated will run the *Mauretania* very close for the blue ribbon of the Atlantic. The world's greatest ship, the *Majestic*, is 912 feet long, and displaces, when fully loaded, 64,000 tons. The turbines, originally designed for 66,000 S.H.P., are supplied with steam from 48 water-tube boilers of the Yarrow-Normand type. These have a total heating surface of 220,000 sq. ft., or some 40,000 sq. ft. more than the boilers of H.M.S. *Hood*. Like most of the Atlantic liners the *Majestic* is now fitted for burning oil fuel. Some 15,000,000 tons of ships burn oil instead of coal to-day, and provided supplies of oil prove sufficient, the time is not far distant when the coal-burning ship will be obsolete. When used under boilers three-quarters of a pound of oil will do the work of a pound of coal. Then, too, the use of oil-fuel leads to a great reduction in the stokehold staff, and from the shipowners' point of view it has the advantage of making it possible to reduce the time of a ship in port. The *Olympic*, for example, can fill her oil-tanks in six hours; coaling used to take 4½ days.

It is not, however, with the reciprocating engine or with the steam turbine that the future of marine engineering appears mainly to lie, but with the Diesel internal combustion engine. Diesel brought out his engine so long ago as 1893. Its success ashore has been remarkable. For driving ships it has had to serve a long probation. The Atlantic was first crossed by a Diesel-driven ship in 1910. Since then its progress has been more rapid, and practically all marine engine builders have taken up the construction of Diesel engines of one form or another. The motor ship has undoubtedly come to stay, and the placing of an order by the Union Steamship Company of New Zealand with the Fairfield Company for a motor driven vessel of 20,000 tons with a speed of 18 knots marks an important epoch in its history. This notable vessel will be 600 ft. long, and will be driven by four sets of Sulzer two-cycle Diesel engines of an aggregate power of 13,000 H.P. This is twice the power of any motor vessel running at present. Such a step is evidence of the degree of trustworthiness and success achieved by the motor ship.

The credit of building the first motor passenger liner belongs to the Elder Dempster Line, which commissioned the *Aba* for its West African trade last year, and has now placed the *Adda* on the same run. Other companies are following the lead thus given, and while in 1914 there were only 297 motor ships afloat there are now 1620, with an aggregate tonnage of more than one and a half million tons. Shipowners have the choice of a dozen types of Diesel engines, such as the Burmeister and Wain, the Werkspoor, the Sulzer, the Beardmore, the Cammellaird-Fullagar, and the Doxford, some being of the four-cycle and some of the two-cycle type. These engines differ in many respects, but all have the same characteristic in being more economical than the steam engine. Mention may also be made of the experiment being carried out with the Still engine, in which the top of the piston is acted upon by the pressure of the burning gases, while the underside is acted upon by the pressure of steam raised in a small boiler heated by the exhaust gases.

In addition to the advocates of the steam turbine and the Diesel engine there is yet another school of engineers which believes the future of marine propulsion lies with what is known as the electric drive. This system has been developed far more in America than on this side of the Atlantic, and all recent capital ships for the United States Navy have electric transmission. In these vessels oil-fired boilers supply steam to Curtis turbines driving electric generators which supply current to the motors on the propeller shafts. The general adoption of such a system, it was pointed out by Prof. Abell, may lead to remarkable alterations in the plans of ships, as the engine-rooms can be placed between decks or otherwise as thought most suitable. A turbine-electric plant involves the use of boilers, turbines, condensers, generators, and motors, but an alternative is to replace the boilers, turbines, and condensers by Diesel engines. The various proposals have been reviewed in his book on "Electric Ship Propulsion" by Commander S. M. Robinson, of the United States Navy. He there divides both naval and mercantile vessels into classes, and states which type of machinery he considers most suitable. For the cargo tramp he would have Diesel engine and electric drive, for other merchant vessels and for large war vessels steam turbines and electric drive, while for destroyers and light cruisers he would retain geared turbine.

From the foregoing it will be seen that the whole practice of marine engineering is, as it were, in the melting-pot, and what the standard form of marine propulsion will be in the future is difficult to see. Given trustworthiness, it is economy which has the deciding influence; economy in weight, economy in space, economy in upkeep, economy in fuel. What the continual striving after economy has done in the past can be judged by the fact that, fifty years ago, to convey a hundred tons of cargo a mile required 18 to 20 lbs. of coal; to-day the same result is obtained with 1½ to 2 lbs of oil. Finality was thought by some to have been reached when the compound engine was introduced. Great advances have been made since then. But while it may not be possible to effect revolutions on the scale of the past, the time is far distant when improvements will be impossible.

Obituary.

Sir James Dewar, F.R.S.

Sir James Dewar died at the Royal Institution, in his eighty-first year, on March 27. He had been working in his laboratory until late on the night of March 20 and was taken ill in the early hours of the following morning.

Our scientific edifice is thus suddenly deprived of one of its main pillars; we shall not easily appraise the loss. The immensity and sustained originality of his genius, the service he rendered to our civilisation, can be but insufficiently appreciated outside the small circle of intimates who witnessed his work and, having penetrated through the thick mask of modesty and reticence which he habitually wore, could disregard his sometimes brusque, inconsequent manner, his volcanic, torrential outbursts of picturesque criticism—knowing these to be but the expression of an extreme intensity of conviction and purpose and an overmastering honesty. At heart he was full of human sympathy, a most gentle and lovable nature—but the presbyter was ever in him.

As an experimentalist Dewar stood alone: there has never been a greater, probably none so great. Science loses in him a worker of peculiar breadth of originality, a most fascinating character; how much the world is poorer it little knows. He was of a type—almost primitive, in this competitive age, in honesty of purpose—now fast becoming extinct, a lineal descendant of his great countryman, Joseph Black, in no way less successful than his predecessors, Young, Davy and Faraday, in adding to the reputation these pioneers created for the Royal Institution as a centre of scientific discovery and invention. He also made it a social centre of great attraction and cast over it an æsthetic spell which it had not previously known. Davy sought society but did not fashion it. Dewar could rarely be persuaded into it but became himself noted as a host, on account of his own great conversational power and the beauty of the surroundings he accumulated: his home was the salon of science and art.

As a lad Dewar met with an accident which, in after life, he regarded as fortunate. Falling through the ice, he contracted rheumatic fever and was long unable to attend school but became intimate with the village joiner. In those days, Scotland having been in close commercial relation with Italy, fiddles abounded and the lad had musical tastes. With his own hands he made several violins, from one of which we heard the sweetest of music conjured forth, by a skilled lady performer, on the occasion of the celebration of his golden wedding, less than two years ago. He always regarded the training he thus received as the most important part of his education and the foundation of the great manual dexterity which he displayed in his work and his lectures. He often complained to me of the sad lack of such ability in the modern student. His master in chemistry was Lyon Playfair. Dewar was one of the few who could appreciate Playfair's great scientific ability and were able to gauge the loss of his early deflexion into the tortuous paths of politics, which Playfair himself regretted in later life. The two men became fast friends and Playfair was long chief admirer of his pupil's brilliant ability. At one time, I believe, Playfair endeavoured to secure his entry into the dyestuff industry; had Dewar's masterful energy been operative in this field our position to-day might well have been one of unrivalled supremacy.

Dewar also came under Kekulé's influence at Ghent. Körner was then assistant in the laboratory and Dewar and he became associated in all sorts of devilry—Körner being a great practical joker and Dewar a wild young Scot. The stamp of the organic chemist was thus burnt into his soul at a critical period—the spell of Körner's marvellous preparative skill being cast over him; he often referred to the time. His mathematical and physical proclivities were thus broadened and he became a complete chemist in spirit. The Dewar benzene-formula, though an imperfect expression of modern knowledge—paper formulæ are but short-hand expressions of character—has not yet lost its vogue. His name is also written in the pyridine chapter. He and I were the first users of sulphuric chlorhydrol, SO_3HCl. He did notable work before he came south—first with Tait, in which he laid the foundation both for his later application of a vacuum in preventing heat exchanges and of charcoal as an absorbent; and with M'Kendrick, with whom he carried out an important inquiry on the physiological action of light.

In 1875 he was appointed Jacksonian professor of natural experimental philosophy in the University of Cambridge and became the colleague of Prof. Liveing. He never carried out the prime duty of his office—the discovery of a cure for the gout—though in early days he sought unsuccessfully for the qualification which might have helped in the work; unfortunately, he only spoilt his digestion and so, in later years, was perforce an extraordinarily careful liver.

Two years after his appointment at Cambridge he also became Fullerian professor of chemistry at the Royal Institution, London. He had twice lectured there previously on the work he had done with M'Kendrick. The second lecture (March 31, 1876), his trial trip, was probably the most carefully prepared, certainly the most logical, discourse he ever delivered; I well recollect how fascinated some of us were by it.

Even if it be possible for a man to serve two masters, the task becomes beyond human power when ghosts aid one of them. As an artist, Dewar had the innate belief of primitive man in ghosts and in the Royal Institution laboratory, miserable as was the accommodation it afforded, the ghosts of Davy and Faraday were ever about him. Let us hope that his successor will be gripped by thoughts of the trinity which Dewar's entry into their Valhalla has established. To have served the Institution honourably, in a way to justify mention in history on a par with them, is an achievement he, in his modesty, scarcely contemplated as possible and yet he ever aimed at it. The feeling that he had so much exceeded Faraday's period of office and not only maintained but also steadily improved the quality of his work, I have reason to think, was year by year a more and more powerful mainspring of action in the indomitable fight against circumstances which he waged during these late bitter times of strife. He was a terrible pessimist.

To return to Cambridge, he found there no tradition of practical achievement to influence him. His colleague Liveing and the Master of his College, Dr. Porter, were perhaps the only men who fathomed his outstanding ability. The crudity of youth was still upon him and the free manners of a Scottish University were not those of conventional Cambridge—his sometimes imprecatory style was not thought quite *comme il faut* by the good. No attempt was made to tame him or provide means for the development of his special gift of manipulative skill. Yet he soon began to exercise an influence which probably has had more to do with the marvellous recent advance of the Chemical School at Cambridge than is commonly supposed. The fine volume of collected researches in spectroscopy which Prof. Liveing and he published a few years ago, is a memorial not merely to their activity but of the example they set as exact observers in a field which, at that time, was in sore need of cautious workers. And the work he did in London had its reflex effect at Cambridge.

Dewar was not great as a teacher. His mind was of too original and impatient a type. He never suffered fools gladly and students are too apt to be foolish—at our old Universities, even to ape the part of superior beings. His forte lay in directing competent hands, not in forming them. He worked himself and through skilled assistants, not through pupils. He was violently impatient of failure in manipulation and his work was almost entirely manipulatory. He, therefore, never created a school. The pity of it is that circumstances were such that he never had a properly large staff. That he accomplished so much with the assistance of the few able men who have aided him is proof of his exceptional skill as a director. It is unfortunate that the Davy-Faraday laboratory was not, from the beginning, organised on lines which would have placed its resources in his hands rather than at the disposal of undirected individual workers; it is a grievous fact that he leaves no followers trained to use his incomparable methods.

Nominally a chemist, Dewar's work lay in fields of his own creation, not borderlands but regions before uncultivated. He was no mere experimentalist but an artist to his finger-tips and in nose, tongue, eye and ear —a perfect judge of *Wein*, *Weib* and *Gesang*, giving to these terms their widest significance; music came next to science in his affections.

Though deeply read and a great lover of poetry and literature, he lacked the gift of ready literary expression—except in his letters and conversation—and was often an incoherent lecturer, yet his lectures were the most masterly and fascinating displays ever witnessed. He set a standard which has made the Royal Institution table remarkable throughout the world. Faraday was celebrated for the simplicity of his style—Dewar is to be thought of on account of the daring of his displays, the wonderful refinement and appositeness of his demonstrations, all most carefully arranged and rehearsed in advance. He was a great scientific actor, playing plays with the most thrilling of plots and entirely original special scenery for each performance. His manner, his brogue, even his impatience, gave a peculiar charm to the impression he produced; but you did well to have been behind the scenes if you wished to gather the full meaning of his message. His demonstrations were unique in character; few realise the infinite loving care he devoted to their preparation. In their simplicity they were often profound. I can never forget the impression I received when I first saw him burn diamond under liquid air—the gradual accretion of the carbon dioxide snow-shower and the blueing of the fluid by ozone, also demonstrated by the iodine test. Then the rapid uprush of the mercury in a barometer-tube full of air when the tube was cooled with liquid hydrogen: it all but knocked the top off. Or again, the production of ozone at the surface of solid oxygen by the impact of ultra-violet radiations. At such moments—and there were many such—the heart beat with joy at the significance of his feats of inspiration.

To the outside world Dewar is known as the man who liquefied oxygen and other gases and as the inventor of the vacuum flask—his name will probably go down the years on this last account. It is due to his memory that this should be spoken of henceforward as *the Dewar flask*: it was his free gift to the public; had he protected and developed the invention he might have amassed a fortune and fully endowed his chair.

The real value of his work on gases, apart from the impetus it gave to the industrial use of liquefied air in particular, is to be found in the many new directions in which he developed the art of inquiry at low temperatures. Perhaps the most illuminating is the inquiry into the heat capacities of the elements at the temperature of boiling liquid hydrogen: the discovery of a periodic variation, corresponding with that in atomic volume at ordinary temperatures, is not only surprising but may well prove to be of profound significance in the future interpretation of atomic properties in terms of electronic structure.

Like his great predecessor, Dewar leaves a mass of material to be interpreted by his successors. Unfortunately, he was all too careless in placing his work on record. Like Turner, he painted for his own pleasure, to give expression to his genius—but too often did not put the picture aside for a Ruskin to glory over.

In two essays printed in the Proceedings of the Royal Institution—one on the "Charcoal Vacuum Septennate" (1909), the other on the "High Vacuum Septennate" (1917)—I have briefly summarised his later and chief work at low temperatures; in the latter I also briefly review his work generally as Fullerian professor up to 1917. These essays may serve to guide students. With him, however, we lose a vast unrecorded experience.

Of late years he had returned to a first love—the soap film: it saved his life and was his solace, keeping him from utter despair during the War. He only left it to go to his last bed of sickness. It is to be feared the record of the work is a very imperfect one. Those who were at his last lecture on "Soap Films as Detectors," on the opening of the Friday evenings this year, will not forget the occasion. He was obviously in physical distress and feeble but mentally as alert as ever; the artist was never more to the fore. His appeal was that made in Cory's beautiful *Incantation*.

My sun is stooping westward. Entrancèd Dreamer haste,
There's fruitage in my garden that I would have thee taste.

But he was the "entrancèd Dreamer"—the fruitage he gave us to taste was lovely; nothing so exquisite had before been brought in such perfect form under the public eye. He recalled Young to us; then, playing with a delicate pencil of air upon his liquid lute, he made visible, in hues of the rainbow, the multitude of its melodies, during over a third of his hour. He had never before lingered so long over a single demonstration. He knew that we were gazing upon no mere play of colour but upon a dance of the molecules such as is at the root of life—and death!

How many of us were serious listeners to the message he felt was to be his last, that he was most bent on making, to his urgent appeal on behalf of the Institution which he had served so long, so well, so nobly—was to serve even up to the moment of his death? He will have worked to no purpose if his appeal be unregarded. The fate and future of science in our country is at stake: nothing less. The Egyptians, thousands of years ago, could make worthy provision for the soul of a boy king of eighteen who had done nothing. Surely our civilisation cannot be so backward, so thoughtless, so unmindful of its present peril, that it will not properly maintain an altar and a virile priesthood to keep alive the memory of men like Davy, Faraday and Dewar in the one way they would all wish—by extending their works in the service of mankind, to its salvation.

H. E. A.

PROF. A. S. BUTLER.

ARTHUR STANLEY BUTLER, emeritus professor of natural philosophy in the University of St. Andrews, died at his residence at Upper Redpits, Marlow, Bucks, on March 3. He was a worthy scion of a family distinguished in the church, in education, in letters, and in athletics. His grandfather, the Rev. Dr. George Butler, senior wrangler, was the distinguished headmaster of Harrow; one uncle was Dr. Henry Montague Butler, master of Trinity College, Cambridge, whose charm of manner he possessed; another uncle was the well-known Arthur G. Butler, Dean of Oriel, a not undistinguished athlete. His father, the Rev. George Butler, D.D., at one time vice-principal of Cheltenham College, was latterly Canon of Winchester; his mother, Mrs. Josephine Butler, an author, philanthropist, and active pioneer in higher education of women.

Prof. Butler was born on May 17, 1854; educated at Cheltenham and at Exeter College, Oxford (of which his father—a Hertford scholar in his day—had been fellow), where he obtained first class in Moderations (mathematics) and first-class honours in the Final School. After further study at Oxford, at Cambridge in the mechanical workshop under Prof. James Stuart, and at Liverpool, he was appointed to the chair at St. Andrews in 1880.

Prof. Butler's experience, especially at Cambridge, made him realise how desirable it is that students of natural philosophy should carry out some experimental work in addition to attending lectures and class demonstrations. But like his predecessor, Prof. Swan, he had the difficulties of want of accommodation and suitable apparatus. In the first year at St. Andrews a special grant provided him with some necessary apparatus, and in a few years he succeeded in obtaining a good practical laboratory well furnished: and then all his students were required to do some practical work.

As a lecturer Prof. Butler was highly successful. His lectures to the ordinary class were characterised by definiteness, with clear, simple, and eminently helpful expositions from fundamental principles; they were illustrated by most successful class experiments and demonstrations highly appreciated and much enjoyed, and were occasionally illuminated by quiet flashes of kindly wit: these were especially effective on the rare occasions when any student tried to make a disturbance. But probably he was at his best in his honours class, where his theoretical treatment was often very elegant and his demonstrations much to be admired.

Prof. Butler was well read, particularly in geography—he was a medallist of the Royal Geographical Society—Napoleon's Wars, and the Peninsular Campaigns. For many years he did much work as an examiner in Mathematics, Pure and Applied, and in English for the Civil Service Commissioners.

Sir William Thorburn, K.B.E., C.B., C.M.G.

The death of Sir William Thorburn, on March 18, at sixty-one years of age, is a loss which will be severely felt in the obscure fields of neurology and surgery which his scientific mind and clinical acumen did so much to illuminate.

William Thorburn was the eldest son of the late Dr. John Thorburn, professor of obstetrics in the Victoria University of Manchester, and obstetric physician to the Manchester Royal Infirmary. He entered the Owens College (afterwards the Victoria University) in 1876 and had a distinguished academic career. He obtained the B.Sc. London in 1880, the M.B. and B.S. in 1884, taking gold medals in medicine, obstetrics, and surgery, with a scholarship in medicine. He proceeded to the M.D. in 1885 and the F.R.C.S. in 1886. On the death of his father in 1885 he took up surgery and held junior posts until he was elected on the honorary staff of the Royal Infirmary in 1890, becoming full surgeon in 1901 and consulting surgeon in 1920.

With a particularly acute and logical mind influenced by the teachings of the late Prof. James Ross, Sir William Thorburn was early attracted to the problems presented by injuries of the nervous system, and his first contribution to medical literature was a paper on "Obstetrical Paralysis," published in the *Medical Chronicle* in 1886; this was followed by a paper on "Injuries of the Spinal Cord" published in 1887 in *Brain*. In the field of research thus early indicated he was a pioneer, and his work resulted in various publications which have made him for many years past a recognised authority all over the world on the surgery of the spinal cord.

In 1891 Sir William Thorburn obtained the Jacksonian prize of the Royal College of Surgeons and was later Hunterian professor; he was also president of the Neurological Section of the Royal Society of Medicine.

Sir William Thorburn was always interested in medical education; a first-rate teacher himself, he trained many who are now teachers in our medical schools, and was successively surgical tutor, lecturer on surgical pathology, professor and emeritus professor of clinical surgery in the University of Manchester. His wise advice and willing help were of great value to the University, not only in the organisation of surgical teaching but also in its general policy and administration. As an examiner he had great experience, particularly at the Royal College of Surgeons, where he was chairman of the Court of Examiners and at the Universities. During the War he was at first, as lieutenant-colonel, in charge of the surgical division of the Second Western General Hospital, afterwards serving with great distinction as consulting surgeon in France and the Mediterranean. He was knighted in 1919.

Of distinguished personality and strong character, with decided opinions, and a fluent and witty speaker, Sir William Thorburn will long be remembered with affection by all who came under his influence.

Current Topics and Events.

As already announced (p. 439), the Government, at the last moment, in deference to the general protest, dropped its proposal to make a charge for admission to the British Museum. It was agreed in the House of Commons on March 26 to delete the clause in the Fees (Increase) Bill which gave power to the trustees of the museum to make regulations imposing charges for admission. The old Act of Parliament remains in force, under which the British Museum is, in the words of Sir Hans Sloane, "preserved and maintained, not only for the inspection and entertainment of the learned and the curious, but for the general use and benefit of the public to all posterity." The public, which has saved its rights, should be grateful to the trustees that they did not adopt the easier course of accepting the Government proposals. Had they done so they would no doubt have placated a Treasury rightly eager to cut down the estimates. They preferred, as trustees for the nation, to take higher ground. As a consequence it seems probable that they will have to renew the fight for an adequate appropriation, if not on this budget, at all events next year. Let the public, and especially the scientific public, be quite clear on this matter. Nobody will wish to gain his freedom of admission at the cost of hampering the curatorial and scientific work of the museum. But that this would be seriously hampered by any further reduction, there is no doubt. When such items as printing, binding, glass-ware, and cases for storage and exhibition are about doubled in cost, even an amount equal to the pre-war grants is hopelessly inadequate. No cutting down can be tolerated. Let the trustees continue to maintain a firm front in the highest interests of the nation, and they will be assured of national support.

According to an evidently inspired article in the *Children's Newspaper* for March 17, Dr. Alfred Daniell, of Edinburgh, author of a well-known "Text-book of the Principles of Physics," has elaborately reconsidered the whole theory of the Michelson-Morley experiment to his satisfaction, and has come to a revolutionary conclusion. Dr. Daniell does not care to debate whether the shift of interference bands expected by Michelson is likely to occur, or whether the smaller value elaborately worked out towards the end of his life by Prof. Righi of Bologna is more likely to be correct. For according to him it is not the shift of bands that is important, but the fact that such bands appear at all. He has convinced himself that in the Michelson experiment no interference bands ought to appear unless there is an enormous relative motion between earth and ether. Hence, from the fact that interference bands do appear in every repetition of the experiment, Dr. Daniell concludes that such relative motion, amounting to 12,000 miles a second, is proved to exist. As the interference part of the Michelson-Morley experiment is of a straightforward and elementary character, it is difficult to understand how Dr. Daniell can have persuaded himself, and can seek to persuade others, that a motion of the ether is necessary in order to account for the appearance of interference bands when a beam of light is split into two halves and afterwards reunited. The premises upon which this deduction is based are not clearly stated in the article, though several equations are given from which it is apparently deduced, but they must include an error which Dr. Daniell has overlooked.

Sir Arthur Keith, in the first of his Hunterian Lectures on "Man's Posture: its Evolution and Disorders," which appears in the *British Medical Journal* of March 17, reviewed the results of recent investigations which throw fresh light on how, when, and where man came by his erect attitude. He pointed out that extinct forms of man indicate that the upright carriage of the head was evolved later than the human form of the lower limb, of which the origin must be sought in Miocene or possibly Eocene times. He distinguished three phases of evolution. In the hylobatic phase the gibbon was differentiated from its cousins, the Old World and New World monkeys, by postural adaptations of bones and muscles in virtue of which it was orthograde and human in type as opposed to the pronograde monkeys. This differentiation probably took place towards the end of the Eocene period. The troglodytic phase was represented by the great anthropoid apes, evolved from the small anthropoids probably in pre-Miocene times. In the plantigrade phase, structural changes were confined almost entirely to the lower limbs. Seeing that man shares so many characters in common with the great anthropoid apes, Sir Arthur Keith held that man must be regarded as one of several aberrant branches of one great stem which began to break up into the various fossil and living forms at the beginning of the Miocene or the end of the Oligocene period.

Visitors to Kew during the next few weeks should make a point of seeing a special exhibit of sports requisites arranged in Museum IV., the Museum devoted to British forestry. In this exhibit are to be seen cricket bats, tennis and badminton rackets, croquet mallets and balls, hockey sticks, and other articles in various stages of manufacture. Special interest is attached to the cricket bat, for, among the many thousands of woods known to science (upwards of 5000 kinds are represented in the Kew collections), no wood has been found that makes a suitable substitute for the best English willow (*Salix cœrulea*) for the blades of bats. The material for the handles cannot be grown in the British Isles; that is the product of one or more tropical palms, *Calamus* spp. (Sarawak Cane). The heads of hockey sticks, the frames of tennis and badminton rackets, cricket stumps, and the handles of croquet and polo mallets are made of the best British ash, while croquet balls are often made of beech, and polo balls of willow. Various other articles are shown, but those mentioned suffice to indicate how dependent the sport-loving public is upon the home-grown timber industry.

The Director of the U.S. Coast Geodetic Survey announces that Congress, at its recent session, made an appropriation of two thousand dollars to the State department for the support of the International Latitude Observatory at Ukiah, California, during the fiscal year 1924, or until some other provision is made for that station. In the estimates for the Coast and Geodetic Survey for the fiscal year 1924 there was included an item which, if it had been approved by Congress, would have authorised that bureau to carry on the variation of latitude observations at Ukiah as a part of its regular geodetic work. It is hoped that this authority will be granted during the next session of Congress in order that there may be no possibility of a break in the observations for variation of latitude which have been made continuously at Ukiah for the last twenty-three years.

While the specification and measurement of artificial light has been brought to a very fair state of precision, there has, until recently, been little corresponding advance in dealing with natural illumination. The chief work in this field has been in connexion with the design of windows for schools, and an exhaustive report on this subject was issued by a committee of the Illuminating Engineering Society shortly before the war. A very complete survey of natural lighting, accompanied by an account of some highly interesting methods of measurement, was presented by Messrs. P. J. and J. M. Waldram at the meeting of the Illuminating Engineering Society on March 27. These methods are based on the relation between the value of unrestricted outdoor daylight illumination, and the illumination at a specified point in a room, a factor which should be substantially independent of climatic conditions and should serve as an indication of the access of daylight. Of special interest was the account of methods of estimating the effect of obstructions to light and the predetermination of daylight-access in buildings. These have recently proved extremely valuable in ancient light cases. Mr. J. W. T. Walsh gave some account of the work on parallel lines being done at the National Physical Laboratory, and paid a high tribute to the experimental skill revealed in the paper.

It is stated in *Science* of March 16 that Mr. A. H. Fleming, of Pasadena, for many years president of the board of trustees of the California Institute of Technology, and its chief financial supporter, has recently given the Institute about 840,000*l*. as a permanent endowment fund. This gift, with Mr. Fleming's previous donations, make a total of more than a million sterling, which he has handed over to the Institute. In making this benefaction, Mr. Fleming recommends that the Institute should "specialise in research in chemistry and physics, under the direction of the most competent men obtainable, with the most liberal provision, in the way of salaries and equipment, for the prosecution of such work." He suggests that efforts should be made to seek out and assist "the superior student," and expresses his conviction that "the institute should always remain a privately endowed institution."

The Paris correspondent of the *Times* announces that at a conference presided over by M. Le Trocquer, Minister of Public Works, on March 31, it was decided to recommend that Strasbourg time as well as summer time should be abandoned, but that during the summer trains should run half an hour earlier. It is hoped that work in Government offices will begin half an hour earlier from April 28 to November 3, and that business and manufacturing firms will adopt the same course. The Brussels correspondent of the *Times* reports that the Royal order fixing the establishment of summer time in Belgium for midnight on March 31 has been revoked, pending an agreement with neighbouring countries.

The lectures at the Royal Institution after Easter begin on Tuesday, April 10, when Sir Arthur Keith will deliver the first of a course of four lectures on the machinery of human evolution. On following Tuesday afternoons there will be two lectures by Prof. A. C. Seward on the ice and flowers of Greenland and the arctic vegetation of past ages; and three by Prof. Flinders Petrie on discoveries in Egypt. On Thursday afternoons, commencing April 12, Prof. A. O. Rankine will give two lectures on the transmission of speech by light; there will be three lectures by Prof. J. T. MacGregor-Morris on modern electric lamps, two by Prof. E. G. Coker on engineering problems solved by photo-elastic methods, and one by Sir William Bayliss on the nature of enzyme action. Two Saturday afternoon lectures will be given by Dr. Leonard L. B. Williams, on the physical and physiological foundations of character, and two by Dr. Arthur Hill on the vegetation of the Andes and the New Zealand flora. The Friday evening meetings will be resumed on April 13, when the discourse will be delivered by Prof. W. H. Eccles, on studies from a wireless laboratory. Succeeding discourses will probably be given by Major W. J. S. Lockyer, Prof. C. V. Boys, Prof. F. Soddy, Prof. W. A. Bone, Mr. W. M. Mordey, and Prof. H. A. Lorentz.

The council of the Geological Society has awarded the proceeds of the Daniel Pidgeon Fund for the present year to Mr. Howel Williams, of the University of Liverpool, who proposes to investigate the stratigraphy and vulcanicity of Snowdon.

In view of the need for retrenching expenditure, the Government of India has decided to discontinue the publication of the Journal and Bulletins of Indian Industries and Labour after the issue of Vol. III. Part 1 of the Journal and of the Bulletins which are now in the press.

The Secretary for Mines has appointed a subcommittee of the Explosives in Mines Research Committee to carry out investigations on the means employed for firing explosives. The members are: Sir Frederick L. Nathan, Mr. J. D. Morgan, Mr. W. Rintoul, and Prof. R. V. Wheeler.

The following sympathetic message has been sent by the King and Queen to Lady Dewar through Lord Stamfordham: "The King and Queen have heard with much regret of the death of Sir James Dewar and desire me to express their true sympathy with you in your loss—a loss which will be shared by the whole world of science."

The Prince of Wales has, according to the *British Medical Journal*, signified his intention of being present at a dinner to be held on May 15, to celebrate the one hundred and fiftieth anniversary of the Medical Society of London. Lord Dawson of Penn, president of the Society, will preside, and a gathering widely representative of the medical profession is expected. The Medical Society of London, which was founded by Lettsom in 1773, is the oldest medical society in England; the Royal Medical Society, Edinburgh, is somewhat older, being founded in 1737.

At the annual general meeting of the Ray Society on March 16, the following officers were re-elected:—*President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Mr. Joseph Wilson was elected a vice-president, and Mr. C. H. Beston and Mr. H. Taverner were elected new members of council. In the report of the council it was announced that the final part of Prof. McIntosh's "British Marine Annelids" would be published at an early date, forming the issue to subscribers for the year 1921. On behalf of the Society, congratulations were offered to the president on the completion of this monograph, of which the first part was published just half a century ago. The fifth and final volume of the "British Desmidiaceæ," prepared by Dr. Nellie Carter, is now ready for press, and will be issued to subscribers for the year 1922.

The issues of the *New Leader* from February 9 to March 9 contain a series of articles on "The Structure of the Atom," by the Hon. Bertrand Russell. These articles provide an interesting popularisation of modern work in atomic physics. Thus the idea that the universe seems like a clock running down, with no mechanism for winding up again, is compared with the experience of a tribe of insects which live for only a single spring day, and may therefore think it strange that there should be ice in the world, since they would find it always melting and never being formed. The electron moving from one stationary state to another is compared to a flea, which crawls for a time and then hops; or to a man who, when he is insulted, listens quietly for a time, and then suddenly hits out. It is perhaps difficult for a technical reader to assess correctly the value of a popular article, but in this case a high standard appears to have been reached.

THE National Research Council of Japan has commenced the issue of journals dealing with astronomy and geophysics, chemistry, physics, geology and geography, botany, zoology, medical sciences and engineering, at intervals determined by the amount of matter available. The first six of the ten parts of the *Japanese Journal of Physics* for the year 1922 have been issued and cover 48 pages of original contributions, including one on the band spectrum of mercury by Prof. Nagaoka, and 26 pages of abstracts of 71 papers published by Japanese workers, and supplied by the authors themselves. The whole of the Journal is in English, and this fact will lead to a better knowledge and appreciation of the large amount of research work which is now being done in Japan.

THE Australian National Research Council has issued a report of its annual meeting held in Sydney in August last. The council was formed for national and international purposes in January 1921 by the Australian Association for the Advancement of Science, to which body it has to submit a full report of its work and proceedings on the occasion of each meeting of the Association. At the meeting Sir David Orme Masson was elected president of the council in succession to Sir Edgeworth David. Resolutions were passed urging the need for the State endowment of systematic research in the Pacific islands under Australian control, for research work in Australia in respect of refrigeration, and for laboratories to carry out industrial investigation and research. Offers of co-operation with the Commonwealth Institute of Science and Industry in measures for furthering these objects were made, and preliminary steps taken for the inauguration of a publicity campaign for the purpose of securing that the functions, operations, and financial needs of the Institute may be more fully appreciated by the Commonwealth Government, the Legislature, and the public generally. The council has decided to ask the Australian Association to regard it as a fully constituted body free to conduct its own affairs subject to instructions from the International Research Council. The first issue of *Australian Science Abstracts*, published by the Australian Research Council as a quarterly journal of abstracts of papers by Australian scientific workers, appeared on August 1, 1922. An invitation has been issued by the Commonwealth Government through the Research Council to the representatives of the Pan-Pacific Scientific Congress to hold the Congress in Australia in 1923.

THE Third Report of the Council of the National Institute of Agricultural Botany reveals satisfactory progress in the establishment of the work of the Institute upon a firm basis. The appeal for fellows has met with a gratifying response, and special interest attaches to the fact that the Prince of Wales and the Duke of York have consented to become honorary fellows. In the Crop Improvement Branch the conditions have now been settled on which yield trials of cereals will be carried out, and four new barleys were included in the "full trials" in 1922 at four different stations. The final year's trials will be carried out in the same districts in the spring of 1923. Varieties of oats, wheat, grasses, and clovers are all under observation, and the Institute is collaborating with the Plant Testing and Registration Station of the Board of Agriculture for Scotland, in the collection of strains of certain grasses and clovers, with the view of collecting information as a basis for a future scheme of trials and registration. Special research has been carried out by the official Seed Testing Station as to the value of "hard seeds" in clovers, and of the "broken growth" which occurs in germination tests. Increases have been made in the fees charged for seed testing in order to reduce the net cost of operating the station. At the Potato Testing Station, Ormskirk, various trials of immunity, maturity, and yield have been steadily carried on, more than 2000 entries being received for the official immunity tests. Progress has been made in the work of the Potato Synonym Committee, and less synonymous varieties are now being entered for the immunity trials.

THE second Sorby Lecture, delivered in the autumn of 1921 by Prof. C. H. Desch, has recently been published and is entitled "The Services of Henry Clifton Sorby to Metallurgy." As Prof. Desch remarks, Sorby was one of those amateur lovers of science who have played such a remarkable part in the scientific history of this country. Some have been members of noble families, such as Robert Boyle in the seventeenth and Henry Cavendish in the eighteenth centuries. Others have been men of the merchant or professional classes, possessing sufficient means to allow them to follow the bent of their minds. Such were Justice Grove, William Spottiswoode, Edward Schunck, and, greatest of all, Charles Darwin. To this group belonged Sorby. Free from the cares of a profession, he gave himself wholly to science, in the effort to advance which he worked with extraordinary diligence throughout a long life. Sorby was a pioneer in many branches of science, but left it to others to develop his new experimental methods and to fill in the details of his discoveries. His great manipulative skill and patience led him to found at least two new departments of experimental science — microscopical petrography and metallography. Prof. Desch has attempted to discover in the wide range of Sorby's scientific work, some connecting thread among the great diversity of his investigations, and he finds that a prominent motive in his work is the desire to understand the "form" of natural objects, using this word in its widest sense. The address deals, in the main, with that branch of Sorby's work which led to the foundation of metallography as a science. It is based on a careful study of his note-books and specimens, and may be commended to all those interested in this matter, as an impartial and penetrating survey of the subject.

We have received from the Eastman Kodak Company their latest catalogue, No. 9, dated January 1923, of organic chemicals. There are 1500 chemicals listed, with prices, most being products of the Eastman Kodak laboratories.

The latest catalogue (No. 8, 1923) of second-hand books issued by Mr. W. H. Robinson, 4 Nelson Street, Newcastle-on-Tyne, although dealing mainly with works in general literature, contains sections devoted to voyages and travel, folklore, and books relating to the north country. The prices asked appear to be very reasonable.

The announcement list of forthcoming books just received from Messrs. Methuen and Co., Ltd., contains particulars of many works of scientific interest, several of which are translations. Consideration of space permits reference to only a selection of titles. Among the translations are "The Origin of the Continents and Oceans," Prof. A. Wegener, translated, from the third German edition, by J. G. A. Skerl; "The Principle of Relativity," Profs. Einstein, Lorentz, Minkowski, Sommerfeld, and Weyl, translated by Drs. G. B. Jeffrey and W. Perrett; "The New Physics," Prof. A. Haas, translated by Dr. R. W. Lawson; "Atomic Structure and Spectral Lines," Prof. A. Sommerfeld, translated by H. L. Brose; "Recent Developments in Atomic Theory," Prof. L. Graetz, translated by Dr. G. Barr; "Crystals and the Fine-structure of Matter," Prof. F. Rinne, translated by W. S. Stiles; and "The Mechanism and Physiology of Sex Determination," Prof. R. Goldschmidt, translated by Prof. W. J. Dakin. Of the English science books in the list we notice the following: "Interfacial Forces and Phenomena in Physiology," Sir William Bayliss; "A Manual of Histology," Prof. V. H. Mottram; "A Text-book of Intermediate Physics," H. Moore; and "The Vault of Heaven," Sir Richard Gregory.

Our Astronomical Column.

Meteors of March 17.—Mr. W. F. Denning writes to record that several conspicuous meteors were observed on March 17. At 7 h. 9 m. a fireball was seen from near Durham, travelling from a point considerably south of the Pleiades to α Andromedæ. Its motion was slow, and it left a trail which, however, quickly disappeared. The radiant point was probably in Canis Major, near the bright star Sirius.

At 10 h. 8 m. a rather bright meteor of first magnitude was seen by Miss A. Grace Cook at Stowmarket. It passed through the eastern region of Canis Minor and was directed from near β Geminorum. It left a train. The same meteor was seen from Bristol, and it traversed a short path between α and ζ Boötis, the direction being from β Boötis. A comparison of the observations shows the radiant to have been at 309° + 76°, and that the height of the meteor was from 66 to 48 miles over the region of Epsom and Horsham. The shower in Cepheus to which the meteor belonged was seen in the third week of March, both in 1877 and 1887. At this period of the year it supplies rather bright meteors with slow motions and trains. It appears to be an annual display, and a radiant in the same position has been observed at other periods of the year, notably in August, September, and October.

The Brightening of Beta Ceti.—*L'Astronomie* for March gives a few more particulars of the observations of this star in February. Mr. William Abbott telegraphed from Athens on February 14, 10 a.m., to M. Flammarion: "Éclat subit de β Ceti, supérieur à Aldébaran." M. F. Quénisset at Juvisy glimpsed the star on February 18, but mist prevented estimation of its magnitude. But on February 23 the sky in its neighbourhood was remarkably clear, and he could observe the star from 6 p.m. till $6^h\ 25^m$ when it disappeared behind a tree near the horizon. He saw it with the naked eye in spite of the bright twilight. *It was at least of the first magnitude* (italics in original). An exact measure was impossible so near the horizon. The magnitude in "connaissance des temps" is 2·24.

On the other hand, Mr. E. O. Tancock (B.A.A. Journ. No. 5) searched for the star by day in a clear sky on February 28 and March 3 without seeing it, though he could see Mira Ceti (estimated magnitude rather fainter than 2). Beta Ceti was lower down, but he considers that he would have seen it if it had still been of magnitude 1 on those days. His observations suggest that the increase of light was short-lived.

Vesta.—Vesta, the brightest of the asteroids, is now an easy object with binoculars, in the middle of the constellation Leo. It is due south at 10 o'clock at the beginning of April. The following ephemeris, by Mr. Bawtree, is from the B.A.A. Handbook for 1923:—

Greenwich Noon.	Mag.	R.A. h. m.	N. Decl.
April 9	6·60	10 43·2	19° 20′
,, 17	6·68	10 41·2	19° 11′
,, 25	6·77	10 41·2	18° 49′

The British Astronomical Association is undertaking the work of providing ephemerides of the four brightest asteroids. The B.A.A. Journ. No. 5 contains an ephemeris of Pallas, but as this will be in a much better position for observation in two months, we defer giving its place.

Old Egyptian Water-clocks.—Several ancient time-observations, such as the statement of the equality of day and night at the equinoxes, make it clear that some form of clock was employed. It is therefore interesting to note that casts of two Egyptian water-clocks have lately been presented by the Egyptian Government to the Science Museum, South Kensington. One, from Karnak, dates from the reign of Amenhotep III. (b.c. 1415–1380); the other, from Edfu, is of the Ptolemaic Epoch; in the former, time is measured by the uniform escape of the water; in the latter, by its uniform admission. In each case there are twelve different scales, corresponding to the length of the night or day in different months. Each of these scales is divided into twelve equal parts, showing that an "hour" was at first of variable length, being one-twelfth of the length of the day or night at the particular time of year.

Claudius Ptolemy collected the observed times of the phases of a number of lunar eclipses; these were used by several investigators, including Newcomb, Cowell, and Fotheringham, in studies of the moon's secular acceleration. As the times were presumably observed with some such instruments as those now exhibited, their study is of some astronomical importance.

Research Items.

EARLY HISTORY OF THE SIOUX TRIBE.—In the Journal of the Washington Academy of Sciences (vol. xiii. No. 3), under the title of "New Light on Early History of the Siouan Peoples," Dr. J. R. Swanton produces new evidence, largely based on phonetics, of the former distribution of this race. He summarises the results of his inquiries as follows: "The occupancy of the territory of our Middle West between the great Lakes and the Ohio by Siouan tribes seems to rest on grounds almost historical. With the strong indications now at hand there seems reason to think that a close comparative study of the Siouan dialects would enable us to reconstruct the general outlines of their ancient geographical positions with considerable accuracy. If present indications are not deceptive, when that is done we shall find that they fell into four major linguistic groups: a north-eastern, consisting of the ancestors of the later Siouan tribes of Virginia, the Hidatsa, Dakota, Biloxi, and Ofo; a south-eastern, including most of the later Siouan peoples of the two Carolinas; a south-western, composed of the five tribes of Dorsey's Dhegiha group; and a north-western, Dorsey's Teiwere."

HIGH-ALTITUDE MOUNTAINEERING.—Basing his conclusions on his experiences in climbing Mount Everest, Mr. G. I. Finch discusses the equipment for high-altitude mountaineering in the *Geographical Journal* for March. Up to 21,000 ft. the climber's physical functions were practically unimpaired and good sleep and recuperation from fatigue were possible, but at 23,000 ft. sleep was fitful, appetite fell off, and there was a general loss of physical fitness. The conclusion is that at, say, 22,000 ft. acclimatisation to altitude ceases and above that height oxygen should be used, at first in small doses, and from 26,500 ft. in larger doses, but the dose must depend on the nature of the ground. It must also be remembered that oxygen increases the appetite, and due provision must be made for this. The stimulating effect of cigarette smoke was noted at 25,500 ft. Although greater heights than these were reached without the use of oxygen, Mr. Finch thinks this procedure unwise, and believes that above the acclimatisation level a man must become steadily weaker and unable to recover from fatigue unless he makes use of oxygen. The article contains also some hints on clothing, footgear, and apparatus.

NEW PLANTS UNDER CULTIVATION.—Part II. of Vol. 148 of *Curtis's Botanical Magazine* shows that figures and descriptions under the new editor, and conditions of publication, will maintain a high level. Among the plants described by Dr. Stapf, four are due to the activities of collectors in China; two new Rhododendrons, *R. sulfureum* Franch. and *R. planetum* Balf, a delightful Labiate from Yunnan named by Forrest *Dracocephalum Isabellæ*, and a small-fruited hardy apple *Malus toringoides* Hughes. Two orchids, *Maxillaria Fletcheriana* Rolfe and *Cirrhopetalum tripudians* Parish et Reichenb., two succulents, *Euphorbia anoplia* Stapf (S. Africa) and *Echinocactus undulatus* Dietr. (Mexico), two other African plants, *Amorphophallus coffeatus* Stapf and *Lachenalia convallariodora* Stapf, are described, together with one plant from the Afghan Indian frontier, *Lonicera Griffithii* Hook. f. and Thoms., a honeysuckle that seems to offer some difficulties in cultivation, although it has been grown in an unheated conservatory successfully and with very pleasing results.

BRITISH CYTOSPORA.—In the *Kew Bulletin*, No. 1 for 1923, W. B. Grove has provided descriptions of the British species of Cytospora which will be of great value for mycologists, particularly for phytopathologists, as these fungi do considerable damage, especially among fruit trees. Cytospora is the name given to a conidial form, producing upon the branches of the host plant pustules and ultimately roundish discs, from the centre of which conidial discharge is indicated by a black point or little tendril of conidia held together by mucilage. When the full life-cycle can be traced, it will probably be found that all the species can be shown to be stages in the life-history of some Pyrenomycete, such as Valsa, Valsella or Eutypella. The necessary cultural experiments, to connect these conidial stages with their specific ascophorous form, should be carried out during the next few years in the cases where the host plants are cultivated plants of value. The British locality for a large number of the 62 species described is given as Kew Gardens, presumably because suspicious twigs are more frequently removed for expert examination from Kew than from trees that are less closely examined. Mr. Grove's list will, however, be an incentive to a more general study of the British species of Cytospora.

THE OLDEST ROCKS OF MARYLAND.—Following the general trend of opinion as research progresses among pre-Cambrian rocks, Eleanora B. Knopf and Anna T. Jones ("Stratigraphy of the crystalline schists of Pennsylvania and Maryland," *Amer. Journ. Sci.*, vol. 205, p. 40, January 1923) assign a sedimentary origin to the oldest known rocks of Maryland, which are styled the Baltimore gneiss. There is no tendency to revert to the old view that gneisses were deposited from primordial hot solutions. Their layer-structure represents normal sedimentary sheets, in which a complete recrystallisation of the constituents has taken place. Some dynamic metamorphism is traced in portions of the mass; but the principal feature of alteration appears to be due to invasion by a batholitic granite magma, with consequent *lit-par-lit* injection. This fact leads the authors to write of the composite rock as an "intrusive complex of early pre-Cambrian age," an expression that surely misrepresents the general conclusion at which their work arrives. The distribution of metamorphic masses in the local Palæozoic series is anomalous, and the presence of subjacent batholitic invaders is suggested.

A GREAT STRATIGRAPHICAL SEQUENCE.—The enormous vertical sections provided by the Grand Cañon of the Colorado River in Arizona remind one of the old-fashioned geological diagrams, in which the succession of known strata was represented as continuous at one spot and based inevitably on a floor of granite. Yet even the 4000 feet of horizontal beds exposed by the stream-cut at Bass Trail tell us nothing of what went on between Cambrian and Devonian times, and include, as Mr. L. F. Noble's detailed study shows, several notable if lesser unconformities. In Professional Paper 131B, United States Geological Survey (1922), Mr. Noble does not confine himself to the Bass Trail section, of which he gives a drawing worthy of reproduction as a lecture-diagram. He provides photographic studies of various unconformities, which the casual visitor would find it difficult to trace, and concludes with the suggestive outlier of Lower and Upper Triassic strata, forming the flat-topped Cedar Mountain, two miles from the cañon edge. His discovery in 1920 of the frond of *Callipteris conferta* in the Hermit Shale is regarded by Mr. White as definitely fixing the Permian age of that formation, which occurs 900 feet below the top bed of the Kaibab Limestone on the cañon rim. The author, despite the possibility of an unconformity at the base of the local Permian, uses the name Carboniferous rather than Permo-Carboniferous for the whole sequence, a course that seems unwise, in view of international usage. Fossils are, on the whole, rare in these splendid sections; but Pennsylvanian and Mississippian strata are both identified, above a small representative of Upper Devonian with Bothriolepis. The whole of the Gotlandian and Ordovician systems are unrepresented, and we pass down into undisturbed Upper Cambrian beds some 900 feet above the stream.

RANGER OILFIELD, TEXAS.—The Ranger Oilfield is situated in the north-west of Eastland County, Texas, and is one of the most important latter-day developments of the great Mid-Continent Oilfield region of the United States. Oil was first struck here in 1917, beginning with the bringing in of the McClesky well at 2000 barrels per day. In 1918 the best wells had an initial production of 6000-7000 barrels of oil, and the total output for that year amounted to more than 6,000,000 barrels. In 1919 the wells collectively made more than 73,000 barrels of oil per day. Since that time a steady production has been maintained, though a noticeable decline is apparently manifest at the present time. The geology and structure of the field have recently been dealt with by Frank Reeves in Bulletin 736-E of the United States Geological Survey. Production is from nine oil-sands occurring in the Strawn Series, Smethwick Shale, and Marble Falls Limestone, all of Pennsylvanian age. The structure is that of very slightly inclined strata, the tilt forming part of the general monoclinal feature of the region as a whole. Locally, low pitching anticlines have been formed which have an important bearing on the accumulation of oil in the rocks involved. The oil obtained from the Ranger field is of a high quality, of mixed base, and has an average specific gravity of 0·84; it yields about 30 per cent. of petrol. It is to be regretted that the bulletin, describing as it does one of the most important oilfields of the south Mid-Continent, is not so well illustrated as many which embrace far less noteworthy properties; in particular the index map is almost unreadable. The large structure maps included at the back of the publication are, however, unusually clear and are of great educational value apart from real technical utility.

METEOROLOGY OF THE SOUTH ATLANTIC.—Mr. H. H. Clayton makes reference in the U.S. *Monthly Weather Review* for November 1922 to a communication in the monthly bulletin of the Argentine Meteorological Office on the physical condition of the South Atlantic during summer by Mr. R. C. Mossman. The communication was to aid the relief ship sent by the Argentine Government each year to and fro between Buenos Aires and the South Orkneys to carry a party of new observers and to bring back the observers of the previous year from the most southern meteorological station in the world, which has been regularly maintained for the last twenty years. The period dealt with is comprised by December, January, and February. Charts prepared are said to show the position of the controlling high and low atmospheric pressures, and wind-roses are given for each 5° square and for each of the three months. Fog frequencies are stated to be shown for each wind direction. Allusion is especially made to the difference between a fog formed by a warm wind blowing over cold water and a fog produced by a cold wind over water at a higher temperature—the fog in the latter case extending to a much greater height, but the base not always reaching the earth's surface. The British Meteorological Office has thoroughly discussed the weather of the South Atlantic, extending to the South Orkneys, in a volume of monthly charts (M.O. No. 168) published twenty years ago.

THE ROAR OF THE MOUNTAIN.—A presidential address to the Washington Academy of Sciences was given on January 9 by Prof. W. J. Humphreys of the U.S. Weather Bureau, entitled "The Murmur of the Forest and the Roar of the Mountain," which is reproduced in Vol. 13, No. 4, of the Journal. Reference is made to historical instances recognised as of weather significance through past ages, and the roaring of the mountain is taken as an indication of a general storm within six to twelve hours. The particular region dealt with is the Gap Mills valley of Monroe County, West Virginia, but the discussion has common reference to mountain meteorology. It is shown how occasionally there are strong winds simultaneously up both sides of a high mountain ridge, and it is asserted that when there is an appreciable wind from the mountain there is often a lighter surface wind in the opposite direction up portions of the mountain itself. With tempest winds the conditions are said to be much like the Helm Wind along the west side of the Pennine range. Reference is made to the familiar singing or humming of telegraph or telephone wires. The tree and forest sounds are said not to be due to the elasticity of the twigs and branches but, as in the case of the singing telegraph wires, to the instability of the vortex sheets their obstruction introduces into the air as it rushes by them. The pitch of the æolian murmur of a forest is said to be essentially that of its average twig, and though the note of the twig may be inaudible at close quarters, the forest may often be heard miles away. Cloud and humidity are dealt with, as are also rain and snow.

A LUMINESCENT CHEMICAL CHANGE.—An interesting example of luminescence occasioned by chemical change in solution, which is said to be more intense than the usual experiment involving the oxidation of pyrogallol, is described by W. V. Evans and R. T. Dufford in the February number of the Journal of the American Chemical Society. A solution of *p*-bromophenyl magnesium bromide in ether is prepared by the Grignard reaction between 2·4 grams of magnesium and 23·6 grams of *p*-dibromobenzene in 130 c.c. of dry ether, with a little iodine. The solution exhibits luminescence which can be observed in daylight when shaken in a test-tube in an atmosphere of oxygen. The luminescence spectrum lies between $\lambda5200$ and $\lambda3500$.

INNOCUOUS METOL.—It is well known that metol, which is one of the most popular of photographic developers, suffers from the grave disadvantage that if it is allowed to come into contact with the hands it may cause persistent and exceedingly irritable sores. Mr. W. F. A. Ermen, of the British Dyestuffs Corporation, finds that almost certainly this is not due to metol itself. In a paper read before the Royal Photographic Society on March 20 (*British Journal of Photography*, March 23) Mr. Ermen gave details of the five principal methods for the manufacture of metol which the Corporation tried in 1916. A method of German origin, by the interaction of methylamine and hydroquinone, gave a very good preparation with extreme ease, but caused severe outbreaks of poisoning in both the laboratories and the works. This result was traced to the presence in the metol so prepared of the very soluble and extremely poisonous symmetrical dimethyl-paraphenylene-diamine. The metol prepared by the Lapworth process proved to be quite innocuous.

American Association Meeting at Boston.

THE seventy-sixth meeting of the American Association for the Advancement of Science was held at Boston on December 26-30. Several of the addresses delivered by presidents of sections have appeared in recent issues of *Science*, and brief accounts of some of them are subjoined.

PHYSICS AND GEOMETRY.

In his address to Section A (Mathematics) Prof. Oswald Veblen discussed some of the aspects of postulational geometry in reference to the developments of physics during the last twenty years.

In the classical branches of physics the main elements of the abstract point of view have been implicit in them for a long time. When it is stated with sufficient clearness in physical terms what is meant by undefined elements, unproved propositions, and so on, it is often found that a physicist classifies these as truisms of little importance. So far as practical results are concerned he is justified in this attitude during the earlier and cruder stages of physical theory. But experience is showing that when the results of a more refined experimental technique force a reconsideration of fundamental assumptions, the technique of the study of these assumptions must undergo a corresponding refinement. A recent illustration is afforded by Einstein's theory of gravitation, which accounts for certain observed physical phenomena by casting aside the familiar conception of space and time in favour of a new one, which is just as self-consistent and capable of logical development.

Beginning with elementary geometry, the oldest branch of physics, there is a sequence of statements arranged in a certain logical order, but void of all physical meaning. In order to apply them to Nature, the undefined terms (points, lines, etc.) are identified as names of recognisable objects. The unproved propositions (axioms) are then given a meaning, and when this meaning can be identified with a true statement the theorems which are logical consequences are also true, and the abstract geometry takes its place as a useful branch of physics.

For kinematics it is necessary to have a theory of time: the undefined terms are "instant" and "before" or "after," and the postulates one of the sets of postulates for the linear continuum. The main theorem is that there is a continuous one-to-one correspondence between the instants of time and the numbers of a real number system.

Prof. Veblen has also formulated a set of postulates for "mass" or "substance," observing that the postulates proposed may contain both omissions and redundancies. They have merely been advanced to emphasise the fact that very little work has yet been done in this direction.

ALLUREMENTS IN PHYSICS.

In his address to Section B (Physics) Prof. G. W. Stewart, of the University of Iowa, president of the section, dealt with the attractive nature of some of the problems of physics at the present time.

The investigation of atomic structure becomes so exciting that we may easily forget the absence of clearness in some of our hypotheses. The static theories have the advantage that they give clear pictures of the atoms which can be used in discussion of the physical and chemical properties of the elements as they appear in periodic groups and of the compounds they form. The orbital theories, on the other hand, have been most successful in explaining the spectra of hydrogen and helium, and, by the help of a further hypothesis, the spectra of the alkali metals. In his most recent work Bohr has departed from the simplicity of his original hypotheses and has endeavoured, by assuming electron orbits which may be circular, elliptical, or highly elliptical, and penetrate each other in many ways, to construct systems which would have the properties of the elements of the periodic table. Although this method of attacking the problem is not so rigorous, Prof. Stewart thinks it will prove more fruitful than that of the statical theories.

Acoustics receives little attention from physicists of the present day, but Prof. Stewart points out its allurements, and refers with keen appreciation to the work of the late Prof. W. C. Sabine of Harvard on the acoustics of buildings, which is only just becoming known in Great Britain. The problem of the best angle for a conical horn seems nearing solution and the conception of the instrument as a collector of sound replaced by the proper conception of it as a resonator.

GAS IONISATION AND RESONANCE POTENTIALS.

An address on this subject was given to Section C (Chemistry) by Prof. W. A. Noyes of the University of Chicago. The ionisation potential is the fall of potential through which an electron must move to acquire speed enough to drive out of an atom of a gas on which it impinges one of its outer electrons, known as valence electrons, and the resonance potential is the fall through which an electron must move to acquire speed enough to displace an electron of an atom from an inner to an outer ring of electrons. The two potentials should, according to the Bohr theory of the atom, be connected in a simple way with the spectrum of the gas, and many measurements have recently been made to test this theoretical conclusion. The agreement is not so satisfactory as one would desire, and there is considerable difficulty in interpreting the values of the potentials found in experiment in terms of changes in the atoms. Prof. Noyes thinks, however, that it is along these lines that our knowledge of atomic structure and of the mechanism of chemical combination will develop in the future.

GEOLOGY'S DEBT TO THE MINERAL INDUSTRY.

Dr. Willet G. Miller, president of the Section E (Geology and Geography), selected as the subject of his presidential address, "Geology's Debt to the Mineral Industry." He explained that, throughout the history of its development, the progress of the science of geology has been helped to a large extent by work connected with the mineral industry. Werner and his disciples did much for the science of geology in its early development by their investigations of earth-structure as revealed in mines. William Smith, the English civil engineer, whose great work as the "father of geology" is so well known, established the principles of stratigraphical geology as a by-product of his work on engineering problems. He complained that the theory of geology was in possession of one class of men, the practice with another. Logan, the great pioneer of field studies in Canada, especially in the pre-Cambrian areas, declared that for many years he was engaged in coal-mining and copper-smelting, and that his connexion with geology related largely to its economic aspects.

After Logan's time little progress was made in pre-Cambrian studies in Canada until after the discovery of ore-bodies at Sudbury, Cobalt, and Porcupine in Ontario. Meanwhile, on the United States side of the border such advance as was made was the outcome of studies connected with extensive and important developments in the mining of iron ore and copper ore in that region. Indeed, both in its inception and throughout its history the prime motive underlying the work of the United States Geological Survey has been an economic one; and that Survey furnishes an excellent example of the valuable scientific work made possible only by the great utility of the organisation by which it was carried out. Other examples could be given, and Dr. Miller mentions particularly that of South Africa, where the science of geology profited immensely as a result of the establishment of diamond-mining and gold-mining industries.

Dr. Miller had no difficulty at all in showing that geology owes a great debt to the mineral industry. His address will be read with much interest by that ever-increasing band of workers who feel, as he feels, that science and art should be mutually helpful and not distrustful of one another, and that a genuine scientific worker does not necessarily sacrifice dignity by carrying out investigations the results of which are likely to be useful.

Structure and Origin of the Plant Gall.

Prof. Melville T. Cook devoted his address, as president of Section G (Botany), to the subject of plant galls, and thus rendered a service to the workers in a field where literature is very scattered. In America, as in Europe, this study has been shared between entomologists, bacteriologists, mycologists, and other students of plants, and a general comprehensive account is difficult to find; from this address it appears that there is still much work to be done, progress probably having been delayed by the specialist angle from which each investigator has approached the problem.

The old idea that the gall arose as the result of a special fluid excreted by the insect as it punctured the plant has long been discredited; but although it is known that the gall tissue develops *pari passu* with the growth of the larva from the deposited egg, there is very little information as to how the larva reacts upon the plant tissue and whether the effect is produced by mechanical or chemical agencies. The reaction evidently depends in part upon the plant tissue affected, and Prof. Cook lays great stress upon the fact that it is usually only meristematic tissue which is stimulated to abnormal growth; but bearing in mind the conditions under which cork meristem arises in the plant as the result of a wound, it seems probable that in a living tissue the capacity for meristematic activity will usually be found in the proximity of the potential gall-former.

Küster, in 1911, divided gall tissues into abnormal growths, consisting only of parenchyma, the kataplasmas, and growths undergoing further differentiation of tissue, the prosoplasmas. Prof. Cook, and also Wells, have developed this original classification indicating that the more highly developed prosoplasm is a more specialised form of growth which has had its "kataplasmic" stage; the most complex types, such as the Cynipid galls, actually showing differentiation into four zones arranged concentrically around the larval irritant. Galls of fungoid or bacterial origin are also discussed in the light of this description of types of insect galls, and it will interest British botanists to find that Prof. Cook has evidently an open mind as to the analogy drawn by Dr. Erwin F. Smith between the crown gall caused by *Bacterium tumefaciens* and the malignant growths found in the animal. He is evidently inclined to regard Dr. Smith's "embryomas," arising at a distance from the original infection, as due to the disturbance of normal functional activity in the host, just as in the case of the formation of aerial tubers upon the potato as the result of the attack of *Rhizoctonia Solani*.

The Mining Industry of Canada.

Dr. J. B. Tyrrell selected the history of Canadian mining for the subject of his presidential address to Section M (Engineering). In such an address the details of so wide a subject cannot of course be dealt with, but Dr. Tyrrell gave a very clear outline of the general course of progress of the Canadian mining industry. Necessarily, in so doing he has included much interesting information on the development of Canadian metallurgy, for it is impossible to separate these two arts when tracing the history of either in any particular new country, any more than they can be divorced when considering the early history of human civilisation as a whole.

The records of Canadian mining commence as early as 1576 with Frobisher's attempt to find gold on the shores of the bay that now bears his name. Better success attended later efforts to work the commoner minerals, and the history of true mining in Canada may be said to date from the discovery of coal near Sydney, Cape Breton, in 1672, which laid the foundation of the important coal-mining industry and perhaps even more important iron and steel manufacture of the Maritime Provinces. Dr. Tyrrell chronicles the discovery of bog iron ore in the province of Quebec about the middle of the 17th century, and the erection of a blast furnace to smelt this ore in 1737. So far as iron is concerned, the history stops with the erection of charcoal furnaces in Ontario in 1810, followed by another in 1813 in Norfolk County, which remained in blast until 1847. It is to be regretted that Dr. Tyrrell did not carry this particular industry somewhat further. An interesting chapter would be furnished, for example, by the attempts to utilise the iron sands along the north shore of the St. Lawrence: these were discovered in 1767, when a Mr. Molson of Montreal built forges of the Catalan type to smelt them; but his enterprise was commercially unsuccessful though he made good iron, and it closed down after a life of nine years. The same fate attended attempts made afterwards by others, among whom was Dr. Sterry Hunt. A charcoal blast furnace was erected early in the 19th century at Londonderry, Nova Scotia, where a brand of pig-iron, which at one time had a great reputation under the name of Acadian pig-iron, was smelted from ores consisting chiefly of brown hæmatite and ankerite. At this place the first coke blast furnace in Canada was built about 1876 by the Steel Company of Canada, Ltd. Afterwards attempts were made to utilise the interesting fossil ore of Nictaux in the Annapolis Valley, Nova Scotia, but now the important iron industry of this province relies upon the magnificent Wabana ore brought across from Newfoundland.

Dr. Tyrrell describes well and clearly the modern developments in Canadian mining, which he dates from the construction of the Canadian Pacific Railway in 1885, and shows good grounds for his conclusion that in mining "our country offers a field for extensive and intensive research second to none in the world," though he justly emphasises the need for a thorough scientific training for those who are to take the lead in future developments.

Experimental Production of Green and Colourless Hydra.

W. GOETSCH, of Munich, has carried out a series of experiments on Hydra, and has published the results in some half-dozen short papers, two of which form the subject of this notice (*Die Naturwissenschaften*, pp. 202-205, 867-871, 1922). Specimens of Hydra are either green, brown, or grey, and these are regarded by most authors as belonging to distinct species or even genera, though in certain cases the brown and grey are difficult to distinguish. Goetsch points out that the brown and green may also be difficult to distinguish, for some of the former can take green algæ into their endoderm cells and form a symbiotic union similar to that long known in green Hydra.

Goetsch obtained from a warmed tank in the Botanic Garden in Nymphenburg some brown Hydra which showed pathological features, and when he fed these with algæ they developed a green colour first around the mouth, then in the foot region, and finally in the intervening portion, so that in about a fortnight the entire animal had an intense green colour. The spread of the algæ was accompanied by a progressive diminution in the size of the Hydras so that they had difficulty in capturing their prey, the reserve material of the interstitial cells degenerated, and budding ceased. These green examples disappeared from the aquarium, but a few which remained in culture vessels were fed with freshly killed Daphnia and were thus carried through their abnormal condition. The reciprocal toleration between the Hydra and the alga soon becomes an intimate association. Afterwards these Hydra produced buds containing the green algæ, and some of them showed ovaries or testes—apparently two were males and two were females.

It is impossible to determine whether the specimens are *H. attenuata* or *H. vulgaris*. The alga in these green specimens is (as in the true green Chlorohydra) a Chlorella, but differs from that in Chlorohydra in being twice as large, and in being situated in the distal end of the endoderm cells, whereas in Chlorohydra the algæ are near the base of the endoderm cells. These green examples differ further from Chlorohydra in that the symbiosis is easily lost; if the green specimens are kept in the dark or cold the green colour disappears with the exception of a small amount around the base of the tentacles, but on transferring the specimens to better conditions the algæ begin to multiply again. Specimens kept four weeks in darkness lost every trace of their algæ; the only way to make these green again was to introduce into them fresh algæ contained in crushed pieces of green specimens enclosed in the carapace of a Daphnia.

Goetsch suggests that this brown Hydra is a new mutant, and that with the origin of this mutant capable of receiving the algæ in the warm house in the Botanic Garden the conditions were for the first time favourable for the institution of the symbiosis. This union cannot be maintained through the cold of winter, and is not transmitted through the egg. In Nature the Hydras would probably not have come through the first attack by the algæ, for those in the cultures owed their survival to artificial help. If a brown and a green specimen of the same species be cut into two and a brown piece and a green piece be joined together by means of a hair, there is a gradual extension of the algæ into the previously uninfected part.

The problem of the production of colourless specimens from the green Chlorohydra has also been attacked by Goetsch. Colourless examples were obtained by Whitney by placing Chlorohydra in weak glycerine, which caused the endoderm cells to expel their algæ. Hadzi kept Chlorohydra in the dark and they produced eggs without algæ, and he thus obtained alga-free examples one of which was reared. Goetsch kept Chlorohydra under unfavourable conditions—cold, darkness, and lack of calcium—to suppress the growth of the algæ, and then liberally fed the Hydra so that their cells multiplied so quickly that the algæ could not keep pace. After a few weeks of such treatment the buds produced were of a paler colour, especially in the middle region of the body. As this is the region where asexual reproduction takes place, offspring were eventually obtained free from algæ. These whitish specimens are more feeble than green examples, and require careful treatment. A spontaneous return of colour in these white specimens has not occurred, although some of them have lived for four months in the light.

Deep green and colourless pieces were joined together and the spread of the green algæ was studied. Algæ thrust out of the endoderm cells of the green part are taken up with other food by the endoderm cells of the other part, so that after a few days the whitish part begins to exhibit a green colour, even at places distant from the junction. If a bud is formed at the junction of the two pieces it may be half green and half white. Such a bud affords strong evidence against the purely ectodermal origin of buds.

University and Educational Intelligence.

ABERDEEN.—At the spring graduation held on March 28, Sir George Adam Smith, the vice-chancellor, presiding, the degree of LL.D., *honoris causa*, was conferred on Sir William H. Beveridge, director of the London School of Economics; Dr. E. W. Hobson, Sadleirian professor of pure mathematics, University of Cambridge; Dr. W. Mackie, of Elgin, distinguished by his researches on the geology of the north-east of Scotland; Sir George H. Makin, consulting surgeon to St. Thomas's Hospital; and Prof. C. Niven, emeritus-professor of natural philosophy, University of Aberdeen.

The degree of Doctor of Science (D.Sc.) has been conferred on Dr. J. L. Rosedale for a thesis—"On the Hydrolysis of the Proteins of Flesh."

The Senatus Academicus has appointed Prof. Matthew Hay to represent the University at the Pasteur centenary celebrations to be held in Paris and Strasbourg in May.

Prof. Kruyt, Utrecht University, will deliver a university lecture in the faculty of science on May 11.

DURHAM.—Prof. H. Louis, at present professor of mining and surveying, and William Cochrane lecturer in metallurgy at Armstrong College, will vacate his appointments on September 30, 1923, on reaching the retiring age. Prof. G. Poole, of the University of Leeds, has been appointed as professor of mining. This appointment was made by the council on the recommendation of a joint committee of the College and the Durham and Northumberland Coal Trades Association. Dr. J. A. Smythe, at present senior lecturer in chemistry, will take over the William Cochrane lectureship in metallurgy; other arrangements are being made in connexion with the surveying teaching, formerly under the supervision of Prof. Louis.

Prof. R. F. A. Hoernlé, professor of philosophy, has now left England to take up his appointment as professor of philosophy in the University of Johannesburg. The council of Armstrong College will proceed to the appointment of a successor to take up office in October.

Prof. G. H. Thomson, professor of education, and joint author with Dr. William Brown of the "Essentials of Mental Measurement," has been invited by the Teachers' College, Columbia University, New York, to spend next academic year there, delivering advanced courses on psychology. The council of Armstrong College has granted him a year's leave for this purpose.

London.—Presentation Day will be held in the Royal Albert Hall, on Thursday, May 3.

The degree of D.Sc. in biochemistry has been conferred on Miss K. H. Coward, an internal student, of University College, for a thesis entitled "The Formation of Vitamin A in Plant Tissues."

Applications are invited for the Astor chair of pure mathematics tenable at University College, in succession to Prof. M. J. M. Hill, retired. The latest date for the receipt of applications, by the Academic Registrar, University of London, South Kensington, S.W.7 (12 from each candidate) is May 24.

Manchester.—The trustees of the Dickinson scholarships, open to medical students and graduates of the University, have announced the conditions and regulations. The scholarships are as follows: (i.) research travelling scholarship in medicine, of the value of 300*l.* for one year, awarded annually; the scholar is required to spend at least ten months abroad and undertake there original investigation; (ii.) anatomy scholarship (25*l.* for one year), to be awarded to the most distinguished first-year anatomy student; (iii.) surgery scholarship (75*l.* for one year, offered in alternate years to a scholarship in pathology), open to medical graduates of the University; the scholar must devote himself to original investigation; and (iv.) pathology scholarship (75*l.* for one year), on the same lines as the surgery scholarship. Full particulars are to be obtained from Mr. Frank G. Hazell, Secretary to the Dickinson Trustees, The Royal Infirmary, Manchester.

Oxford.—A fund amounting to nearly 2000*l.* has been raised to provide a memorial of the late Sir William Osler, Regius professor of medicine. It has been decided to place a memorial bronze plaque in the University Museum, and to award a medal every five years to a graduate of the University who has made some distinguished contribution to medical science. It is also desired to provide a fund to assist teachers in the University to travel for purposes connected with medical knowledge and research. For this latter object further contributions are required; these should be sent to Mr. A. P. Dodds-Parker, 2 Holywell, Oxford.

The professor of pathology, Dr. G. Dreyer, has been appointed to represent the University at the forthcoming celebration at Paris and Strasbourg of the centenary of the birth of Pasteur.

Mr. M. E. Shaw, of New College, has been elected Radcliffe travelling fellow. The Radcliffe prize has been awarded to Dr. A. D. Gardner, University College, sometime Radcliffe travelling fellow.

The Matteucci gold medal, conferred as a posthumous honour by the International Research Council at Brussels in 1919 on the late Mr. H. G. Moseley, of Trinity College, has been received at Oxford and delivered to his mother, Mrs. Sollas.

The governing body of Exeter College will hold an election in the summer term to a research fellowship of 200*l.* a year, free of income tax, tenable for 5 years. Candidates, who must be members of the University of Oxford of at least B.A. standing, must send in applications by May 15 to the rector, who will supply further details.

Societies and Academies.

London.

Geological Society, February 16.—Prof. A. C. Seward, president, in the chair.—A. C. **Seward**: The earlier records of plant-life (presidential address). Reference was made to the views of Dr. Church on the origin of life in the waters of a primeval world-ocean, and on the origin of terrestrial vegetation from highly-organised Algæ transferred by emergence of portions of the earth's crust above the surface of the water. The vegetation of the land may have received additions from upraised portions of the crust at more than one epoch in the history of the earth. The course of evolution is probably more correctly illustrated by the conception of separate lines of development, than by that of a branching tree implying the common origin of the main groups of plants. The unfolding of plant-life must be considered in relation to the changing geological background. Diffusion-phenomena, as illustrated by the so-called Liesegang figures, possibly explain the origin of some of the structures which are usually attributed to organic agency. We have no knowledge of any Pre-Cambrian land-flora. The phyla of Lycopods and Ferns are regarded as independently-evolved groups. The wide geographical range of Archæopteris was emphasised, and reference was made to the difficult problems raised by the occurrence of Upper Devonian floras well within the Arctic circle, at least equal (in the variety of the plants and in the vigorous development of the vegetation) to the more southern floras of Ireland, Belgium, and other regions.

March 14.—Prof. A. C. Seward, president, in the chair.—E. M. **Anderson**: The geology of the schists of the Schichallion district of Perthshire. Between Carn Mairg and Schichallion the succession is:—graphite-schist: pebbly quartzite: mica-schist: non-pebbly quartzite: schichallion boulder-bed. Following the boulder-bed, and thus on the same side of the quartzite, are a white limestone, a banded series of siliceous and micaceous rocks, a grey carbonaceous limestone, and a slightly carbonaceous mica-schist, which may be named the grey schist. On approach to the white limestone the boulder-bed becomes highly calcareous. This conglomerate is probably a tillite, and has been partly formed from the material of the limestone. There may thus be a chronological sequence, of which the oldest visible member is the grey schist, extending upwards to the Ben Ledi grits in an adjoining part of Perthshire. In the northern part of the Schichallion district the Dalradian series is bordered by the Struan flags. The junction is probably not an unconformity, but either a normal fault which has been affected by strong horizontal movement, or else a folded thrust.—H. H. **Read**: The petrology of the Arnage district in Aberdeenshire: a study of assimilation. The modification of magmas by the incorporation of material of sedimentary origin is here termed contamination. In the Arnage mass in Aberdeenshire the sediments concerned in contamination are: (*a*) andalusite-schists and pebbly grits of the Fyvie series; and (*b*) biotite-schists and subordinate hornblende-schists of the Ellon series. The contaminated rocks occur as a roof-zone, some hundreds of feet thick, overlying a sheet of norite rich in magnesia, and are of four types. Assuming that the initial magma was normal gabbro, the contamination-process depends on reciprocal reaction between initial magma and xenoliths, whereby the magma loses magnesia and lime and becomes richer in alumina and alkalies, the final results of the reciprocal reaction being the granitic Ardlethen type of contaminated rock and certain xenoliths extremely rich in magnesia and lime. The modified xenoliths sink in the acidified magma of the contaminated zone; they pass into the underlying sheet of initial gabbro, which becomes enriched in magnesia and lime, with the formation of the norite now seen beneath the contaminated zone. The chemical variation in the contamination-process is exactly the same as that in igneous rocks as a whole. Reciprocal reaction may play a part in magmatic differentiation, especially in the great gabbro-sheets.

Mineralogical Society, March 13.—Dr. A. Hutchinson, president, in the chair.—A. **Hutchinson**: A graphical method of correcting specific gravity determinations. A diagram is given by which the correction for air displacement and reduction to 4° C. can be read off directly.—A. **Brammall** and H. F. **Harwood**: The Dartmoor granite (Widecombe area). Field evidence and analyses support the conclusion that the granite is a composite laccolite and that four successive stages of intrusion are recorded by (1) dark and relatively basic granites scantily exposed and by certain cognate xenoliths resembling basic segregations; (2) a more acid granite which caps many tors and yields mineral evidence of having assimilated country rock; (3) a still more acid granite intrusive into the latter; (4) minor acid intrusions. Felspars, garnet, cordierite, etc. are described, and evidence for differentiation is given.—C. E. **Tilley**: Genesis of rhombic pyroxene in thermal metamorphism; mineral associations and the phase rule. Free-silica hypersthene-bearing hornfelses of sedimentary origin can be divided into a calcic and non-calcic group, and considered as derived from a normal shale hornfels by increments either of CaO, (MgO + FeO), or less commonly K_2O. Silica-poor hypersthene hornfelses can be derived from the free-silica types, and the hypersthene is then frequently accompanied by spinel. The derivation of all these hornfelses can be graphically expressed in systems of three or four components. The hypersthene is derived from the chlorite in the original sedimentary rocks subjected to metamorphism. Hypersthene arises when enstatite, augite, or amphibole-bearing igneous rocks enter contact aureoles. Rhombic pyroxene is produced by contamination of gabbroic rocks.—C. S. **Garnett**: (1) On a peculiar chlorite-rock at Ible, Derbyshire. A band in the dolerite sill at Ible is completely altered to a foliated mass of chlorite, with associated veins of fibrous chlorite (resembling chrysotile in appearance). The analyses and characters of this material are compared with those of "epichlorite." (2) The dissociation of dolomite. Dissociation is inappreciable up to 625°, and at 898° it is complete. The temperature-dissociation curve is continuous.—J. G. C. **Leech**: Occurrences of rutile, brookite, and anatase in the St. Austell granite. These minerals occur in the red pneumatolysed granites of the area, the mode of occurrence being essentially the same as that recorded for Dartmoor occurrences of these minerals.

Linnean Society, March 15.—Dr. A. Smith Woodward, president, in the chair.—J. **Parkin**: The strobilus theory of Angiospermous descent. The idea that the flower has evolved by reduction from a bisexual cone of a special type is elaborated. This Anthostrobilus is characterised by having the microsporophylls borne on the axis invariably below the megasporophylls; it is peculiar to the Angiosperms, Bennettitales, and Gnetales. From the Pteridosperms, strobilate plants arose either (1) by the segregation of the two kinds of sporophylls into unisexual cones, or (2) by their aggregation into one and the same cone. The Anthostrobilus may have been called into being through the substitution of insect-pollination for wind-pollination. The Angiosperms are regarded as a monophyletic group and the Monocotyledons as of monophyletic origin from the Dicotyledons and of Ranalian extraction. The 8-nucleate sac is taken as primitive for Angiosperms. A return to the Ranales as the starting-point for the evolutionary study of the flower is advocated.

Aristotelian Society, March 19.—Prof. A. N. Whitehead, president, in the chair.—Miss H. D. **Oakeley**: Prof. Wildon Carr's Theory of Monads. The importance as well as the difficulties of this theory lie in its attempt to combine into a unity the points of view of idealism and of creative evolution. The means by which the two viewpoints are brought into unity is the concept of reality as activity. The theory raises complex and many-sided problems in regard to a monad's knowledge, the nature of the material world, inter-monadic intercourse and the ultimate reality within or beyond experience. The problem of knowledge is conceived by Prof. Carr from the point of view of relativity and the doctrine of perspectives. The material universe results from the dichotomy of experience essential to activity, for activity can be conceived only as an opposition of antithetical forces. "Activity" is the core of the metaphysical theory. It is the reality of the monad, and its first expression is the æsthetic creative production of images. The doctrine of the monadic nature of reality is based on intuition, but Prof. Carr claims that modern science confirms his view, arguing that science must postulate that monads constitute the real, in order to make its results fully intelligible. Knowledge according to the theory must be perspective in form, and this also is supported by arguments from modern scientific relativity.

Royal Microscopical Society, March 21.—Prof. F. J. Cheshire, president, in the chair.—M. T. **Denne**: An improved apparatus for the production of photomicrographs. The apparatus consists of a bed made up of two heavy rectangular metal bars, upon which slides a carriage, one end of which is shaped to act as support for the microscope lens system, a separate microscope not being used. The carriage also bears one end of the camera bellows, and an optical bench for the below-stage apparatus. The head of the camera with dark slide fitting is fixed at one extremity of the bed itself. The eyepiece of the microscope is brought through the orifice of the plate-holder fitting, when adjustments may be made, the camera bellows being collapsed over the body of the microscope. For metallurgical work the usual vertical illuminator is employed with a right-angle prism arranged above the main optical axis. The apparatus is compact, although giving 800 mm. camera extension, and, since it is not necessary to swing the microscope out of the axis for preliminary adjustments, difficulties due to decentralisation are eliminated.—A. C. **Thaysen** and H. J. **Bunker**: The destruction of cellulose fibres and fabrics by micro-organisms and the importance of the microscope in the study of this destruction. Destruction of fibres such as cotton and flax involves vast sums of money; the United States Department of Agriculture place the annual damage to American cotton, on this account, at seventy million dollars. Different types of cotton are differently affected. All true Indian cottons appear to deteriorate quickly, at a rate which is constant. American cottons are far more resistant, but they also show a constancy in their rate of deterioration. The greater resistance of American cottons appears to be due to at least two factors: the absence of food, and some more positive factor. This latter appears to be affected by climatic conditions, since American cottons grown in India show, on the addition of food material, an accelerated rate of deterioration. Selective breeding might possibly assist in the isolation of strains of cotton resistant to bacterial attack.—E. **Hatschek**: The standard methods of ultra-microscopy. The methods of making visible those particles small compared with the wave-length of light (100 $\mu\mu$ and less) fall into two classes: (1) illumination at right angles to the axis of the microscope (Zsigmondy-Siedentopff ultra-microscope and Jentzsch ultra-condenser), and (2) axial illumination so arranged that direct light is totally reflected at the cover glass (dark ground condensers, *e.g.* paraboloid, cardioid, concentric, etc.). The performance of the slit ultra-microscope was discussed.

Royal Meteorological Society, March 21.—Dr. C. Chree, president, in the chair.—G. M. B. **Dobson**: Characteristics of the atmosphere up to 200 km., as obtained from observations of meteors. The rate of heating and evaporation of a meteor depends on the air density. Nearly all the kinetic energy of the meteor is finally radiated as visible light, and thus observations of a meteor's total brightness and velocity give its mass. Hence from the observed characteristics of meteors it is possible to calculate the density of the air at the height of their appearance and disappearance. The rate of change of density with height will indicate the air temperature. From eye observations of meteors the temperature of the air is about 220° a. (−63° F.) up to 50 km., thus agreeing with the results of *ballon sondes*. Above 60 km. the temperature is about 300° a. (81° F.), and the density at 100 km. is about 100 times greater than that usually calculated on the assumption of a uniform temperature of 220° a. The high temperature is presumably due to the absorption of solar radiation by the air in addition to terrestrial and atmospheric radiation, due possibly to the presence of ozone formed at great heights by the sun's ultra-violet light. There is indirect evidence of an annual variation of air temperature.

DUBLIN.

Royal Dublin Society, February 27.—Prof. J. A. Scott in the chair.—P. A. **Murphy**: On the cause of rolling in potato foliage; and on some further insect carriers of the leaf-roll disease. The mechanism of rolling of potato foliage as caused by leaf-roll, and incidentally by some other diseases and injuries, is discussed. The cause of rolling in the cases investigated is the distension of the spongy parenchyma following the accumulation of carbohydrate in the leaves. The activities of a capsid (*Calocoris bipunctatus*), a jassid (*Typhlocyba ulmi*), and an aphis (*Myzus Persicæ*) which develops on the sprouts of unplanted tubers, in carrying leaf-roll are discussed.—John J. **Dowling**: The recording ultramicrometer: its theory and applications. The theoretical principles of the device, together with a description of some experimental investigations into the conditions of operation, are discussed. The degree of sensitivity attained under ordinary laboratory conditions is 10^{-7} cm.; this being strictly reproducible and the apparatus quite easy to operate. The operation of the apparatus at still higher sensitivities requires special precautions, such as screening and the like.

March 27.—Prof. J. A. Scott in the chair.—R. L. **Praeger**: Catalogue of scientific and technical periodicals in Dublin libraries. A card-index catalogue showing all the scientific periodicals available in Dublin has been prepared by a special committee. In each case the extent of the sets in each library is shown, together with any breaks which occur. Thus it is possible to ascertain if any number of any periodical, whether current or extinct, is available in Dublin, and where it is to be found. It is proposed to endeavour to improve the supply of such literature by suggesting the discontinuance of some periodicals which are unnecessarily reduplicated and their replacement by others at present unavailable.—W. R. G. **Atkins**: The hydrogen ion concentration of the soil in relation to the flower colour of *Hydrangea hortensis* W., and the availability of iron. The hydrangea produces blue flowers when grown in acid soil, since iron salts are absorbed in larger amounts and react with the pink flower pigment. Iron is absorbed by plants mainly in the ferrous condition, for at ordinary soil P_H values ferric iron is completely precipitated. Ferrous salts are not completely precipitated at $P_H 7$. The lessened solubility in alkaline soils is considered in relation to chlorosis. Iron pan formation is connected with the oxidation of the ferrous hydroxide precipitated when acid soil solution percolates to a region of higher P_H value.—H. G. **Becker** and E. F. **Pearson**: Irregularities in the rate of solution of oxygen by water. A form of apparatus is described which permits the process of absorption to be observed continuously by means of a sensitive water manometer, the temperature being maintained constant to 0·1° C. The results obtained show that during the early stages, absorption follows a logarithmic curve very closely, but after the gas-content has risen to about 70 per cent. of saturation the absorption tends to become irregular. This indicates that the force producing the slow mixing during the early stages tends to become very small, and therefore uncertain in its action towards saturation.

PARIS.

Academy of Sciences, March 12.—M. Albin Haller in the chair.—Luigi **Bianchi**: A kinematic property of W surfaces.—M. Jules Bordet was elected a foreign associate in succession to the late M. Ciamician, and M. J. Cornet corresponding member of the section of mineralogy in succession to M. W. C. Brögger, elected foreign associate.—**Mordoukhay-Boltovskoy**: The logarithm of an algebraic number.—M. **Hadamard**: Remarks on the preceding communication.—M. **Mandelbrojt**: Taylor's series with gaps.—M. **Malaval**: Hardening (of metals). Metals can be hardened not only by longitudinal extension (Seigle) but also by compression, and the latter method was applied in 1912 to a gun, with good results.—Georges **Darmois**: The local integration of Einstein's equations (interior problem).—M. **Cisotti**: Plane movements of liquids endowed with viscosity.—D. **Eginitis**: The reform of the calendar in Greece. A discussion of the political and ecclesiastical difficulties attending the reform of the calendar in Greece.—M. **de Broglie** and E. **Friedel**: The diffraction of the X-rays by smectic bodies. The smectic state is defined as one in which the molecules, having a common direction, are distributed along parallel equidistant surfaces. Such substances should act on X-rays like the system of parallel reticular planes of a crystal. In confirmation of these views experiments on the diffraction of X-rays by solutions of sodium oleate are described. Combined with the experimental figures of P. V. Wells, these results form the first direct measurement of the wave length of the X-rays starting with optical wave lengths, and without making use of either Avogadro's constant or Planck's constant.—J. **Cabrera**: The limits of K absorption of some elements. Results are given for a group of sixteen elements, mainly from the rare earths.—M. **Volmar**:

The photolysis of tartaric acid and the acid alcohols. Solutions of tartaric acid exposed to ultraviolet light give off gas containing carbon dioxide (66 per cent.), carbon monoxide (10 per cent.), hydrogen (21 per cent.), and hydrocarbons. The solution contains an aldehyde and small quantities of a substance resembling the hexoses.—Pierre **Steiner**: The ultraviolet absorption spectrum of veratrol and vanillin. The absorption curve of veratrol resembles that of pyrocatechol: the introduction of two methyl groups into the pyrocatechol molecule has only a slight influence on the spectrum.—Victor **Henri** and E. **Walter**: The law of the distribution of the bands in the ultraviolet absorption spectrum of the vapour of toluene.—Armand **Castille** and F. W. **Klingstedt**: The ultraviolet absorption spectra of benzoic acid and of the three oxybenzoic acids. The ortho- and meta-oxybenzoic acids give nearly the same spectrum, but the para acid shows marked differences in the number and appearance of the absorption bands.—M. **Bourguel**: The preparation of true acetylenic hydrocarbons. Sodium amide removes hydrobromic acid from many brominated hydrocarbons. The reaction can be followed by titrating the ammonia evolved; the yields are good, and there is no tendency to polymerisation of the acetylene derivative.—M. **Lespieau**: The dinitrile of β-oxyglutaric acid, $CN.CH_2.CH(OH).CH_2.CN$.—P. **Diénert**: Subterranean circulation of water in fissured ground.—M. **Solignac**: The tectonic of the country of the Mogods, the plateau of Hédil and of northern Bejaoua (Northern Tunis).—E. **Bauer** and A. **Danjon**: Atmospheric absorption on Mont Blanc.—Jean **Dybowski**: A new industrial force: the utilisation of the heat furnished by thermal springs. A suggestion that the hot water from thermal springs might be utilised for forcing fruit and plants under glass.—P. **Bugnon**: The number of cotyledons of Ficaria. *Ficaria ranunculoides* has been regarded by different authors as containing two, one, or no cotyledons, and the true number has an important bearing on the theory of the origin of the monocotyledons. Ficaria possesses two leaf organs having the same anatomical connexions with the root as the two cotyledons of the dicotyledonous species of the same family: the most plausible hypothesis is that Ficaria is heterocotyledonous.—Marcel **Mirande**: The nature of the secretion of the sterinoplasts of the white lily. The central body of the sterinoplasts is a lipoid solution of phytosterol.—M. **Trabut**: Carpoxeny and bud mutation in cultivated Citrus.—J. **Feytaud**: A plan of campaign against the Doryphore of the potato.—A. **Demolon** and P. **Boischot**: Researches on the assimilability of phosphatic manures. A saturated solution of carbon dioxide was used to dissolve the soluble phosphate, and special attention was given to the effect of the presence of calcium carbonate on the amounts of phosphorus extracted from various types of phosphatic manure.—H. **Hérissey**: The reversibility of the ferment action of α-*d*-mannosidase.—Marcel **Baudouin**: Radiography applied to the study of the lesions of prehistoric human bones. Human remains of the polished stone age have been submitted to radiographic examination with interesting results. Fractures in bones have been detected, certain congenital lesions identified, also a case of chronic osteoarthritis, and two traumatisms due to foreign bodies, one of which is undoubtedly a sharpened flint.—André **Broca** and Jean **Comandon**: The representation of movement in pictures.—Jacques **Pellegrin**: New contribution to the ichthyological fauna of the fresh waters of Morocco.—H. **Bordier**: The influence of diathermic d'Arsonvalisation on the endocrinic glands. Application to the treatment of Basedow's disease. This method of treatment, of which the technique is described, has been applied with success to several cases of exophthalmic goitre.

Diary of Societies.

SATURDAY, April 7.

Gilbert White Fellowship (Annual General Meeting) (at 6 Queen Square, W.C.1), at 2.—Sir David Prain: Presidential Address.

MONDAY, April 9.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—A. Hiorth: Irrigation of Palestine.
Royal Institution of Great Britain, at 5.—General Meeting.
Society of Engineers, Inc. (at Geological Society), at 5.30.—T. Exley-Fisher: The Work of the Labour Corps in France during the War, with Particular Reference to the 178 Labour Company.
Royal Institute of British Architects, at 8.—H. M. Fletcher: The Architecture of Provincial France.
Aristotelian Society (at University of London Club), at 8.—Prof. C. D. Broad: The Natural Meaning of the Unconscious.
Royal Society of Arts, at 8.—E. Kilburn Scott: The Fixation of Nitrogen (1) (Cantor Lectures).
Society of Chemical Industry (London Section) (at Engineers' Club, 39 Coventry Street), at 8.—S. S. Zilva and J. C. Drummond: The Cod Liver Oil Industry of Newfoundland.—E. W. Blair, T. S. Wheeler, and J. Reilly: A Study of the Separation of the Gases formed in the N-butyl-alcohol-acetone Fermentation Process.
Royal Geographical Society (at Æolian Hall), at 8.30.—P. Bigelow: Geographical Influences bearing upon Japan and her Neighbours.
Institution of Rubber Industry (at Engineers' Club, Coventry Street).—Dr. D. F. Twiss: Rubber Pigments.

TUESDAY, April 10.

Royal Institution of Great Britain, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (1). Nature of the Machinery.
Society for the Study of Inebriety (at Medical Society of London), at 4.—Dr. W. M. Feldman and others: Discussion on Racial Aspects of Alcoholism.
Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—A. E. Chambers: Potrero No. 4. A History of One of Mexico's Earliest and Largest Wells.
Zoological Society of London, at 5.30.—Dr. G. M. Vevers: Notes on a Recent Visit to Zoological Gardens in Holland and Belgium.—Prof. K. Kostanecki: A Remnant of the Omphalo-mesenteric Arteries in the Manatee.—Dr. C. F. Sonntag: The Anatomy, Physiology, and Pathology of the Chimpanzee.
Institution of Civil Engineers, at 6.—A. Binns: The King George V. Dock, London.
Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—H. M. Cartwright: Study of Bichromated Gelatine with reference to Photogravure.—W. Clark: The Reduction Centres of a Silver Bromide Emulsion.
Röntgen Society (at Institution of Electrical Engineers), at 8.15.—M. A. Codd: A New Method of Operating Induction Coils.

WEDNESDAY, April 11.

Royal Society of Arts, at 4.30.—E. Parnell: The Resources and Trade of Sarawak.
Institution of Electrical Engineers (Wireless Section), at 6.—Dr. N. W. McLachlan: The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders, and Radio Transmitting Keys.
Institution of Automobile Engineers, at 7.30.—C. W. J. Taffs: Rail-less Trolley Traction.

THURSDAY, April 12.

Royal Institution of Great Britain, at 3.—Prof. A. O. Rankine: The Transmission of Speech by Light (1).
Institution of Electrical Engineers, at 6.—A. G. Warren: The X-ray Examination of Materials.
Optical Society (at Imperial College of Science and Technology), at 7.30.—F. Twyman: The Hilger Microscope Interferometer.—A. Whitwell: The Form of the Wave Surface of Refraction.—J. H. Barton: A New Research Microscope of Original Design.
Institute of Metals (London Local Section) (Annual General Meeting) (at Institute of Marine Engineers, Inc.), at 8.—Dr. S. W. Smith: The Surface Tension of Metals.
Camera Club, at 8.15.—E. A. Robins: The Edible Crab.

FRIDAY, April 13.

Royal Astronomical Society, at 5.
Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Madder-stained Specimens illustrating the Process of Bone-growth.
Malacological Society of London (at Linnean Society), at 6.
Junior Institution of Engineers, at 7.30.—C. B. Clapham: Instrument Equipment of Aeroplanes.
Royal Photographic Society of Great Britain, at 8.—J. R. H. Weaver: Cathedrals of Northern Spain.
Royal Institution of Great Britain, at 9.—Prof. W. H. Eccles: Studies from a Wireless Laboratory.

PUBLIC LECTURE.

TUESDAY, April 10.

Gresham College (Basinghall Street), at 6.—W. H. Wagstaff: Geometry. (Succeeding lectures on April 11, 12, and 13.)