NATURE

SATURDAY, JANUARY 30, 1926.

CONTENTS.

Electric Supply in Great Britain.

UNTIL the details of the Government electric supply scheme for Great Britain outlined by Mr. Baldwin on January 15 are published, it is only possible to discuss the scheme in a general way. It may be useful, however, to give a brief survey of the conditions affecting electric supply in Britain. The proposals are of national interest, affecting directly not only the electrical industry but also the many industries for which electric power is a necessity. They also affect every one who uses or in the future may use electricity for domestic purposes.

Situated all over the country are 584 public supply stations. A few of these are large and highly efficient, but several are getting antiquated. They are operated by private companies, municipalities and "joint authorities" in accordance with the Electric Lighting Act of 1919. Some of these are authorised to supply electricity in bulk, and these will retain their powers. After the electricity is generated it is transmitted to distributing stations, where the business of the engineers is to make arrangements for supplying consumers with electric power and light. The scheme is to eliminate gradually the inefficient generating stations and convert them into distributing stations. They will purchase their electricity in bulk from a central board, which will own a huge distributing network of mains. This board will purchase its electricity from a selected number of existing generating stations, and after paying the small expenses of management and the interest and sinking fund on its network, will apply any surplus to the cheapening of the cost to the consumer.

The scheme is not exactly novel, as a somewhat similar one was suggested for Great Britain and discussed in the electrical press last year. It seems, however, to have been studied in detail by the Electricity Commissioners, who approve of it. It will be useful, therefore, to consider the beginnings of electric supply in Great Britain and to discuss some of the problems that will want careful consideration. There will be no Government subsidy, but the interest on the capital required to purchase the transmitting mains and to pay for the cost of their erection will be guaranteed by the Government under the Trade Facilities Act.

The evolution of the method of supplying electricity over considerable distances was started by Ferranti about forty years ago. He designed a station at Deptford for generating electrical energy at 10,000 volts and transmitting it to substations in London, where it was transformed down to lower pressures and distributed to consumers. The site was chosen in a place where there was abundant water for condensing purposes and where coal was cheap owing to the low costs of transport. The late Lord Crawford was very enthusiastic over the scheme and was one of its strongest supporters. It needed great courage and great faith in science in those days to undertake such an experiment. It is interesting to remember that it is this station which supplies the power required by the Southern Railway to work its electrified sections. Ferranti is universally recognised as the pioneer of modern electric supply. The Government legislation of this period made electric supply very difficult. London was divided up into small areas, each of which was to be supplied by two companies, one using direct current and the other alternating current, the idea being that the competition between the two would tend to cheapen the supply. Under such conditions, it is surprising that any company survived, seeing that security of tenure was only given for a limited number of years.

In 1919, only seven years ago, the Government again introduced legislation affecting the industry. The country was divided up for electrical purposes into a number of districts, each of which was practically autonomous, and powers were given for the erection and working of large generating stations by joint authorities. The new scheme considers that England is not too large to be considered as a single unit, the generating, transmitting and distributing parts of the industry being kept quite distinct. It has been very cleverly arranged that the new scheme will gradually come into operation with the minimum disturbance of existing arrangements, and yet, in ten or fifteen years' time, the great bulk of the public who use electricity will be supplied at very much cheaper rates.

At first sight, we picture this national system of transmitting lines as extending from Land's End to Thurso, and from Glasgow to Newcastle, Birmingham and London. To diminish the cost of transmission, if not 220,000 at least 110,000 volts must be used. A little consideration, however, will show that the cost of the mains required in this case would be altogether prohibitive. Still we consider that in ten years' time the length of the lines necessary to link up all the centres of supply will be at least 2000 miles and the cost of overhead mains would be at least 6,000,000*l*. It has also to be remembered that there will be a heavy additional expenditure at the distributing end of the mains due to the rotary converters or mercury arc rectifiers which would probably be used to lower the pressures and convert the alternating current supplied into direct current.

It will be seen that a national transmission network can only be erected at a very great capital cost, and interest, depreciation and maintenance will be very heavy items. But we think that, provided the scheme is not rushed unduly but allowed to develop gradually, it is a good and sound commercial proposition. In any case, owing to the Government guarantee, we think that the requisite capital will easily be obtained. It has been suggested that it may be possible in the future to transmit electric power through the ether without transmission cables at all. With our present knowledge of science, however, this suggestion, like the corresponding one of obtaining energy from the atom, need not be seriously considered for many years to come.

In our opinion, Mr. Baldwin perhaps laid unnecessary stress on the standardisation of the frequency. Most electricians agree that 50 should be the standard frequency and that every new station should have this frequency, but there is no urgent necessity for scrapping the existing generators and apparatus which work at other frequencies. It is a very simple operation to link two networks together by suitable synchronous motor-generator sets so that power can be transformed from one to the other quite easily.

This national network will provide a large number of problems for mathematical engineers. In Great Britain, hitherto, it has been permissible to assume that the capacity and inductance of the mains can be supposed to be concentrated at particular points of the mains. In the future, this assumption will seldom be admissible as the networks will be large and hyperbolic sines and cosines will have to be used in making the requisite calculations. Again it will not be sufficient to assume that the most economical site is the centre of gravity of the load. Lengthy calculations will have to be made, and the problem of finding which site is the best will have to be investigated much more minutely in the future than in the past. Competent mathematicians should be in great demand.

Unfortunately, there is not yet a 1,000,000 volt testing transformer at the National Physical Laboratory for testing the high voltage insulators which will have to be used. Progress in this direction should be accelerated. The physics of the brush discharges, generally called the corona, which appear sometimes on high tension mains, have been thoroughly investigated in the United States.

Mr. Chattock, in his presidential address to the Institution of Electrical Engineers, pointed out that it would be very difficult to supply rural districts at a reasonable rate by tapping the high tension mains directly, as this is always a costly process. The connexions would have to be made at well-defined centres, from which light overhead wires carrying currents at low pressures would radiate in all directions. The present high price of wiring cottages in rural England for the electric light is due to the very stringent regulations under which wiring contractors have to work. On the Continent, the cost is only about a third or a quarter of what it is in England. There is a considerable margin, therefore, for reducing the price of wiring by lowering the pressure of supply sufficiently so that much less stringent regulations could be used.

We hope that something will be said in the promised Bill about electrifying the railways and equipping every coal mine in the country with complete electrical plant for getting the coal and for pumping and ventilating. Expenditure of this kind is immediately remunerative, and the Government guarantee would help to foster what the Americans call "public utility" services.

One great advantage of interlinking supply stations is that the supply of reserve plant will be largely reduced. The Electricity Commissioners have stated that 68 per cent. of the generating plant in Great Britain is normally idle. We were glad that the Prime Minister in his speech laid stress on the necessity of educating the public to the many domestic uses to which electricity can be put. The demand is certain to increase as the points of supply are multiplied and the price per unit reduced. It can nearly always be used economically for cooking and in many cases for heating. If the price of electricity be sufficiently reduced, chimneys will be a relic of barbarism. This Bill should give electrical engineers a great opportunity of showing how greatly they have benefited by the scientific and technical researches carried out since the War. The maximum water power available to us is only about a tenth that required for our industrial needs. Looked at from the electrical point of view, Britain is a very compact country with plenty of fuel available for many years to come. We look to our engineers to conquer the forces of Nature to further the welfare of the nation.

The Life of the Salmon.

The Salmon: its Life Story. By W. J. M. Menzies. Pp. xii+211+36 plates. (Edinburgh and London: William Blackwood and Sons, 1925.) 21*s*. net.

PROBABLY there is no vertebrate animal, except the eel, whereof the secret of its life-history has yielded so recently to systematic observation and research as the Atlantic salmon. Just as in 1896 Battista Grassi succeeded in demonstrating that the small marine fish previously classed as Leptocephalus was none other than the alevin of the eel, so in 1840 did John Shaw, gamekeeper at Drumlanrig, by confining a number of parr, hitherto accorded specific rank by ichthyologists as *Salmo salmulus*, prove that they assumed the seasonal smolt livery before being released to descend to the sea, whence they should return as *Salmo salar*.

That marked an important advance in our knowledge of one of the most valuable food-fishes; but many years passed without any further progress being reported. So late as 1886 we may read in the ninth edition of the "Encyclopædia Britannica" a statement that the smolts increase so rapidly in size after reaching the sea that they return *in the same year* as sexually mature salmon. "It is surprising," is the writer's naïve comment, "that a smolt weighing only a few ounces should increase to 3 or 4 or even 6 lb. in about three months."

It was not until 1904 that Mr. H. W. Johnston announced his discovery that the age of every salmon was automatically registered on the hyalo-dentine surface of every scale on its body. This fresh light, combined with the result of marking some 6500 smolts in the Tay, as undertaken jointly by Mr. Calderwood, Salmon Fishery Inspector for Scotland, and the late Mr. P. D. Malloch of Perth, followed by the recapture of a small percentage of the marked fish on their return to the river, has redeemed from all doubt the chief facts in the life-history of the salmon. The conclusions registered have been confirmed by observations in many other rivers, notably by those conducted by Mr. J. Arthur Hutton in the Wye of Hereford.

In "The Salmon: its Life Story," Mr. W. J. M. Menzies has undertaken to summarise these conclusions and to describe for the general reader the method by which they were attained. As Assistant-Inspector of Scottish Salmon Fisheries, he has borne an active part in the marking and recapture of salmon and in registering the results. His narrative is enriched by incidents of independent observation and illustrated by many photographs. Among the latter must be noted one serious omission, namely, that in none of the numerous figures of salmon scales is there any indication of scale in another sense, although all are shown many times larger than life This is specially perplexing, because the illustrations of smolt scales are not made from scales taken from smolts, but represent only the central portion of the scales of adult fish.

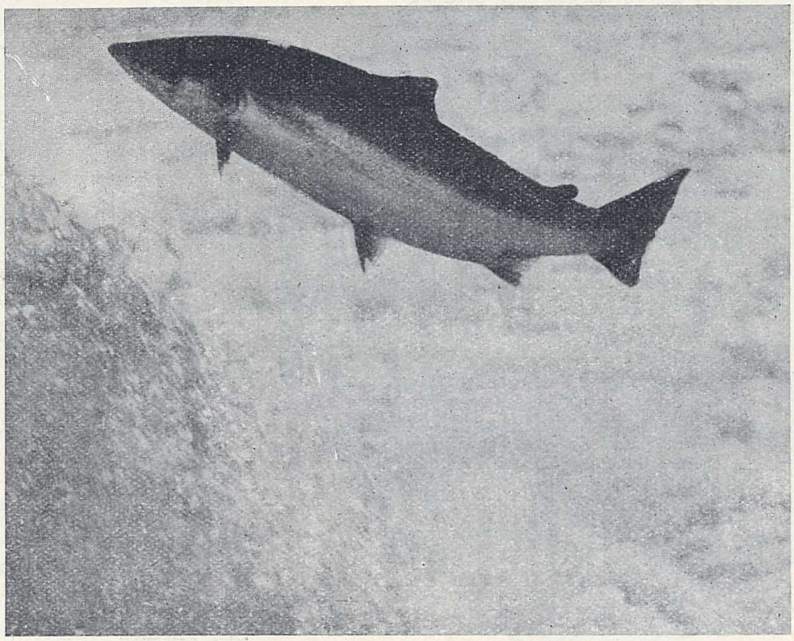

FIG. 1.—Salmon jumping at Ballyshannon Falls, R. Erne, Ireland. From "The Salmon: its Life Story."

The scales of a salmon do more than merely registering its age and periodical intervals of fasting; the spawning crisis also is indicated by the peculiar scar which may be seen four times repeated in Fig. 2. Recognition of the spawning scar has revealed the fact that, although salmon may and do spawn as grilse and at any subsequent age, it is but a small percentage that do so more than once.

"Investigations in the east coast rivers, as well as in catches taken in the coast nets, have shown that in the total catch of the season the proportion of previously spawned fish is very seldom more than 5 per cent., and, on occasion, may be less than 2 per cent. The exact proportion varies from year to year, but in general is in the neighbourhood of 4 per cent."

Observation on this point has been chiefly conducted hitherto on the east coast of Scotland. Such investigation as has been effected on the western seaboard indicates a much larger percentage. It was found that among the large number of salmon taken in the Add of Argyll, no less than 34 per cent. had previously spawned. The effort of spawning greatly exhausts the fish, far more among the males than the females, the majority of the former dying before reaching the sea. The spawning mark on the scales is caused by the total absorption of the margin of the scale, during the sojourn in the river, the whole muscular fabric of the fish being also seriously depleted and deteriorated. It is remarkable that simultaneously with this depletion, the jaws of the male salmon should be greatly prolonged, a great hook being formed on the lower jaw fitting into a corresponding socket in the upper jaw. The purpose of this peculiar growth has been the subject of much speculation without any approach to explaining it.

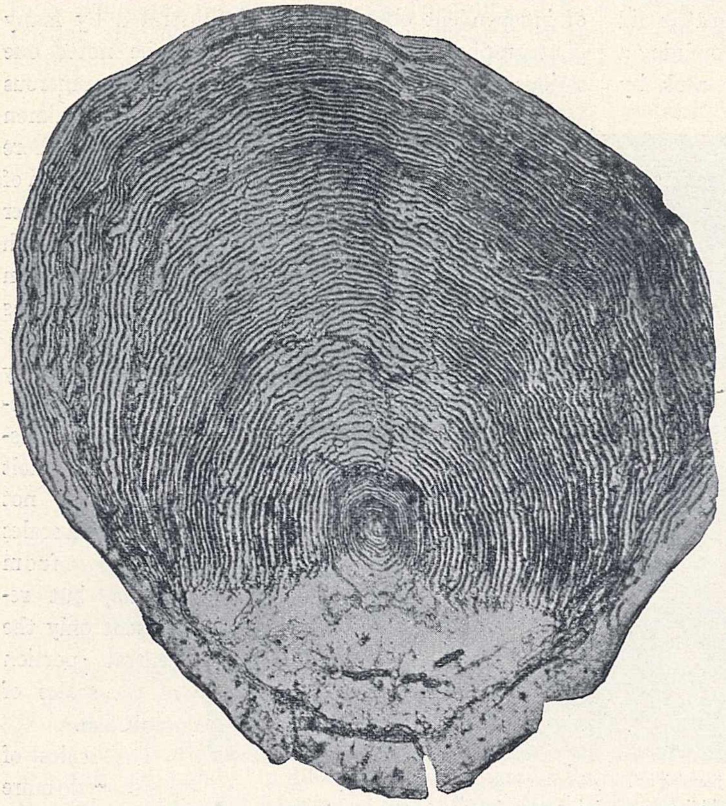

FIG. 2.—Scale of a salmon which spawned four times. From "The Salmon: its Life Story."

No question is more frequently—often hotly—discussed among anglers than whether the salmon feeds in fresh water after its return from the sea. As a parr, of course, it has to rely upon river fare; but rivers, especially Scottish rivers, provide no food sufficient to nourish lusty adult salmon, which, it must be remembered, frequented them in incalculably greater numbers before the stock had become decimated by netting and other modes of capture. Like every other scientific observer, Mr. Menzies holds strongly the opinion that a salmon fasts as soon as it leaves the sea, often, indeed, before doing so if hindered by drought or other impediment. Among other instances he quotes the result of investigation conducted in the Tweed, where it was found that out of 1442 salmon taken in the estuary, 128 (9 per cent.) contained remains of food in their stomachs, whereas none among 252 taken higher up the river retained any trace of food in stomach or intestine. It may be long before fishermen will agree in acquitting hungry-looking kelts of cannibalism; it will be longer still before suspicion will be confirmed by discovering remains of food in their stomachs or intestines.

Mr. Menzies has contributed a most useful and convenient review of the recent advance in knowledge of the life-history of the salmon, rendered possible by Mr. Johnston's discovery and interpretation of scale-marks and carried into effect by the systematic vigilance of the Fishery Board of Scotland.

HERBERT MAXWELL.

A New Survey of Architecture.

Architecture. By Sir Thomas Graham Jackson. Pp. xi + 366 + 111 plates. (London: Macmillan and Co., Ltd., 1925.) 25*s*. net.

THIS compact and well-produced volume on the growingly popular subject of the art of building is the work of no less an authority than the late Sir Thomas Jackson, Bart., R.A. The manuscript, fortunately, was completed before his death, and this posthumous book is the last from his facile pen. It is stated in the preface that "it is hoped that the book may act as an incentive" to the reading of his greater works, "Byzantine and Romanesque Architecture," "Gothic Architecture," and "The Renaissance of Roman Architecture."

The work differs from a text-book in the ordinary sense, for it is not a complete study of past art; it does not profess to be a history of architecture pure and simple. It is in no way a general essay on architecture, and though larger than a handbook is less comprehensive than a text-book; it is rather a critical study and summary of special periods, and is of a suggestive nature, which should stimulate thought and study. The work of the ancient nations of Egypt, Mesopotamia and Persia is practically omitted, and very little is said even as to the Greek and Roman styles; one chapter suffices to deal with the earlier work of each. It concentrates chiefly upon the subjects treated in the author's earlier works. It is a searchlight thrown upon certain phases of architecture.

This pleasant book is written in an easy narrative manner—a method of treatment which is all the more noticeable when a number of more or less independent styles and buildings are dealt with in rapid succession. It should convey, even to a reader little acquainted with the subject, a clear and comprehensive idea of the best buildings of the different types discussed. The illustrations, which include excellent half-tone photographs and some characteristic sketches by the author, with a few plans and elevations, are well distributed throughout the letterpress. The author has recognised that even in a general summary it is essential to show the structural motives and principles of building, before the external or internal design can be appreciated; this is clearly shown by the brief but helpful explanations of constructional expedients, such as the use of "orders" or rings of an arch in Romanesque and the construction of the vault in Gothic architecture.

Perhaps the most interesting features of the book, however, are the critical essays forming the introduction and epilogue. In the former the vexed question, "What is Architecture?" is courageously considered, and the author insists again that the true nature of architecture "does not consist in beautifying building, but on the contrary in building beautifully, which is quite another thing."

In a new work one looks to see what is said as to doubtful or disputed matters, and in this connexion it is interesting to find that the pointed arches at Fountains Abbey and Worcester Cathedral are quoted as among the earliest in England, while the famous pointed vault at Durham is relegated to a date twenty-five years later than has been commonly assigned to it. There would appear to be few errors of fact, but the Parthenon plan should show solid walling between naos and Parthenon proper, as the openings, according to Prof. E. A. Gardner, were not part of the original design. Again, the plan of Westminster Abbey attributes the ritual choir, or eastern part of the structural nave, to the reign of Edward I. instead of to the later years of Henry III. (1260–69). The chronological chart, showing the chief buildings in the different countries arranged in parallel columns, is useful, and there is a good index, but no glossary.

In conclusion, it may be said that this work on architecture has a certain character all its own, which fully justifies its publication. One book may have a technical, another a social, and another a religious bias, but this is distinctly human in nature in its treatment of monarchs, patrons and architects who have played their part in the architectural drama. The epilogue is suggestive, in its description of all architecture as either "bond" or "free"—that is, either rigidly confined to a prescribed formalism, or freely adaptable to the genius of the individual. It is clearly emphasised that it depends on this generation to determine the quality of the architecture of the immediate future, and to have a care that the architectural needs of our time are met, in the words of the author, not by "beautifying building" but by "building beautifully," so that the art of man may go hand in hand with Nature in producing beautiful effects.

BANISTER FLETCHER.

Higher Geometry.

(1) *Principles of Geometry.* By Prof. H. F. Baker. Vol. 4: Higher Geometry; being Illustrations of the Utility of the Consideration of Higher Space, especially of Four and Five Dimensions. Pp. xvi+250. (Cambridge: At the University Press, 1925.) 15*s.* net.

(2) *Géométrie du compas.* Par A. Quemper de Lanascol. Pp. xx+406. (Paris: Albert Blanchard, 1925.) 24 francs.

(1) IN 1873 Darboux published his interesting book, "Sur une classe remarquable de courbes et de surfaces algébriques," in which he obtained properties of bicircular quartics, including as particular cases Cartesian ovals, the limaçon and the cardioide, by projection from the curve of intersection of two quadrics. But going on to the corresponding properties of quartic surfaces with a double conic, the cyclides and the anchor-ring, he found it necessary to remark: "Comme on n'a pas d'espace à quatre dimensions, les méthodes de projection ne s'étendent pas à la géométrie de l'espace."

The day has now long gone, we hope, since it was necessary to avoid the use of space of more than three dimensions in order to obtain results in ordinary space; at any rate, Prof. Baker's fourth volume will convince any one of the enormous power of the method. To obtain, from a single configuration in four dimensions, and that so simple, four arbitrary straight lines or, alternatively, six arbitrary points, practically all the surfaces and constructs about the properties of which anything at all is known, the Kummer surface, the Weddle surface, the tetrahedral complex, etc., is surely a remarkable achievement. Again, the quadric in five dimensions, as remarked by Cayley and Klein and examined in more detail by Segre, gives an immediate and much simplified account of that somewhat complicated discipline "line geometry."

The method of projection from higher space can, of course, be applied to more elementary theorems.

Propositions of one-dimensional geometry, of ranges of points upon a straight line, can be made simpler and less algebraical by considering the line as derived by projection from a conic, or, more generally, from the normal curve of order n in space of n dimensions. Circle geometry in the plane, with all its complication and apparent haphazardness, appears as an ordered whole when regarded as obtained by projection from the geometry of plane sections of a quadric. The reviewer well remembers his astonishment when it was first pointed out to him, in lecture, that Wallace's theorem of the common point of intersection of the four circumcircles of the triangles formed by four straight lines was essentially the same, from this point of view, as the theorem about Möbius tetrads, mutually inscribed and circumscribed—a proposition involving only points, lines, and planes. Also the theorem of the Hart circle of three given circles, which is such that the four circles are all touched by four other circles, becomes much more interesting and instructive in three dimensions.

All this, and very much more, is packed into the 244 pages of this volume. The book naturally suffers from the compression and is not one to be read in an arm-chair; indeed, any one page will furnish matter for several hours' cogitation by the ordinary mortal. But it is a fascinating study, and British mathematicians may well be proud of such a splendid mine of geometrical lore as is to be found in the four volumes of "Principles of Geometry."

(2) The "Géométrie du compas" of M. Quemper de Lanascol is a book of quite another kind. There is a mathematical interest in showing that every geometrical problem which can be solved by ruler and compasses can be solved by compasses alone, but this is not a difficult matter. One has only to show that (*a*) the point common to two straight lines and (*b*) the points common to a straight line and a circle, where a straight line is given by two of its points, can be found without a ruler and the thing is done. Alternatively, one can proceed by the method of Adler, by showing how to find with compasses only the inverse of a point with respect to a given circle, and remarking that we have then only to invert the ordinary construction with ruler and compasses, which involves straight lines and circles, to get a construction involving circles only. For an adequate account of both methods reference may be made to the article by E. Daniele in "Questioni riguardanti le matematiche elementari" (1914), t. 2, pp. 25-48; Coolidge in his "Treatise on the Circle and the Sphere" does the whole thing in a couple of pages (pp. 187-8).

But Mascheroni, whose "Geometria del compasso" (Pavia, 1797) is the *locus classicus* of the subject, did not confine himself to the theoretical aspect. He maintained that the practical difficulties of making a perfectly straight edge rendered it important to avoid the use of such an instrument, and his book is filled with ingenious constructions, as simple as may be, for all the problems of elementary geometry, obtaining each point of the figure as an intersection of two circles. He also gave approximate constructions, by the same means, for problems of higher than the second degree and for transcendental problems, the duplication of the cube, the quadrature of the circle, and so on.

The present volume contains all that is in Mascheroni and, in addition, gives a section on inversion. The material has been rearranged, much new matter has been added, from various sources, and the result is a great improvement on the prolixity of the "bon abbé." The book will appeal to the mathematical amateur who delights in what the author deprecatingly terms "une sorte d'acrobatie géométrique," especially when he reads how Napoleon lectured his band of savants on this very subject, evoking from Laplace the remark: "Nous attendions tout de vous, général, sauf des leçons de mathématiques." F. P. W.

Our Bookshelf.

Male Infibulation. By Eric John Dingwall. Pp. vii + 145. (London: John Bale, Sons and Danielsson, Ltd., 1925.) 10*s.* 6*d.* net.

THIS work is the first volume of a series which the author is undertaking in connexion with some of the more obscure customs of antiquity and the Middle Ages related to the sexual life of man. The book consists of three chapters dealing respectively with three forms of the practice to which the term infibulation has been applied, namely, the Roman form, the Greek form, and phallus curvatus. In the Roman form, where alone the term is applicable, a ring or similar object is attached to the prepuce. The operation was chiefly performed on singers, musicians, and slaves, the principal object being to preserve the quality and tone of the voice, which was supposed to be corrupted by sexual indulgence, while the subsidiary reason was to prevent masturbation. In the Greek form, which was principally adopted by athletes and is represented on Greek statues and vases, the practice consisted in tying up the prepuce with a small band, either because the Greeks were ashamed of a short foreskin associated with uncovering of the glans, or because they believed that physical strength could better be preserved in this way. The phallus curvatus, which is often depicted on the vases and statues of antiquity, especially among the followers of Dionysus, the Sileni, and Satyrs, and was by no means uncommon among revellers and caricatures, is regarded by the author as symbolic of a life of sexual excess, and therefore as having no possible connexion with infibulation. The work, which has obviously involved an immense amount of literary and artistic research, is a valuable contribution to the sexuological department of anthropology.

Dairy Engineering. By John T. Bowen. (Wiley Agricultural Engineering Series.) Pp. xiv+532. New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 18*s.* 6*d.* net.

THIS volume deals with the principles of engineering and their application to dairy practice. The method of presentation is clear and the subject matter well arranged, so that the book will serve as a useful and trustworthy guide to the dairy engineer, and also as a text-book to the student of dairying.

After a preliminary chapter on definitions, the subject of great importance in dairying—namely, the raising and application of steam—is dealt with. First the boiler and its fittings; then combustion and firing; then control of the air supply, which is an important factor in the economical use of fuel. The types of steam engine usually employed are described and their advantages and disadvantages discussed. As a proper arrangement for the carrying of steam to the different appliances is not infrequently overlooked in designing a factory, the chapter dealing with steam piping and accessories is of special interest. Attention is also directed to the advantage which is gained by the use of exhaust steam, as by its employment much can be done in dairy practice.

The chapters dealing with refrigeration and insulation are good, but no detailed consideration is given to such operations as pasteurisation or cream separation. The internal combustion engine and various types of electric motors are considered in detail so far as their applicability to the dairy factory goes. The advantages and disadvantages of electric power are also discussed. There is a chapter on temperature measurement and control.

Admiralty Handbook of Wireless Telegraphy, 1925. Prepared by Capt. W. G. H. Miles. Pp. viii+547. (London: H.M. Stationery Office, 1925.) 5*s.* net.

THE style of this book is lively and spirited and the information conveyed is clear and accurate. It is meant for the information and guidance of officers and men of H.M. fleet, and the editor is to be congratulated on making the subject so interesting. The modern theory of electricity is first described, and so the theory of thermionic tubes follows very convincingly later on. Resonance is first described analytically and then illustrated by what happens in daily life. We are told to "walk across a room carrying a cup of tea, and note . . ." The "jar"—the Service unit of electrostatic capacity—which equals the 900th part of the microfarad, is much in evidence and so also is the "mic" (the microhenry). W/T and R/T seem to be the contractions used in the Navy for wireless telegraphy and radio telephony respectively, and this book proves that they are very convenient.

There are one or two slips that might be altered with advantage. The lines of magnetic force round two parallel wires carrying equal currents flowing in opposite directions are circles and have not the oval shape shown in Fig. 18. The modified type of Fourier series, also, shown on p. 439, will certainly not represent any kind of wave form. But these are very small matters. Considering its value it is a very cheap book, and can be strongly recommended.

The Extra Pharmacopœia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Eighteenth edition. Vol. 2. Pp. xlii+728. (London: H. K. Lewis and Co., Ltd., 1925.) 20*s.* net.

WHEN "Martindale" was divided into two volumes on the issue of the fifteenth edition in 1912, the dividing line ran roughly between drugs used in the treatment of disease, which were dealt with in volume 1, and an account of recent therapeutical research which, with much bacteriological, analytical, and other information of value to medical men and pharmacists, composed volume 2. This arrangement, which has proved convenient in practice, is still maintained, and as this is the third edition published since the division took place, it is clear that in its new form the book has lost none of its popularity.

Only those familiar with the enormous output of work, of very varied quality, in therapeutics and the associated sciences, can have any idea of the trouble expended by the authors in selecting material for inclusion, and of the labour necessary for the presentation of the approved data in the highly condensed form with which users of this book have become familiar. These two features are as characteristic of this edition as of its numerous predecessors.

The senior author will have the cordial sympathy of all his readers in the loss of his collaborator, Dr. Wynn Westcott, who died at Durban on July 30, 1925, while this edition was in the press.

Grundlinien zur Entwicklungsmechanik der Pflanzengewebe. Von Dr. H. Pfeiffer. (Abhandlungen zur theoretischen Biologie, Heft 20.) Pp. vi+99. Berlin: Gebrüder Borntraeger, 1925.) 6 gold marks.

A GREAT deal of this small volume on a particular branch of "theoretical biology" will be too theoretical for the average biologist. It seems doubtful whether long Latin terminologies and chapters on such subjects as "Die erkenntnistheoretische Begründung der Entwicklungsmechanik pflanzlichen Gewebe" really advance the subject appreciably.

Later chapters, however, are of interest, especially where they treat of recent work in this field, which is such a complex one, and so different in many ways from the corresponding field in animals, that every attempt to summarise and sift critically the materials is bound to be of service. We hope that Dr. Pfeiffer will follow this up by a further volume on the achievements rather than on the theoretical bases of this branch of science.

Mesopotamia: the Babylonian and Assyrian Civilization. By Prof. L. Delaporte. (The History of Civilization Series.) Pp. xvi+371. Translated by V. Gordon Childe. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1925.) 16*s.* net.

THIS is a quite useful summary of present knowledge of the subject, including a short history of each region, and chapters on its institutions, religion, economic and social structure, and contributions to knowledge. There are a number of small line drawings of typical works of art. The translation is not very happy in places, and there are some odd mistakes.

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.*]

The Transmutation of Elements.

IN a letter to NATURE of January 2, 1926, Prof. Smits records the obtaining of evidence of the transmutation of lead into thallium and into mercury. One of our research students has been employed for some time in an attempt to detect the transmutation of lead into thallium, but up to the present the experimental difficulties have not been satisfactorily overcome, and we are not yet able to make a definite statement on the matter as a result of this work. The experiments so far attempted in this Laboratory, and those contemplated in future efforts, have been designed to facilitate the entry of an electron into the nucleus of a lead atom in the hope of effecting a transmutation into an isobare of another element (thallium), rather than to bring about a transmutation by the ejection of a proton or an α-particle from the nucleus of the lead atom.

We may perhaps be permitted to review the results of attempts at transmutation of elements which have been recently recorded in the light of these two alternative possibilities. In the case of the transmutation of mercury (atomic number 80) into gold (79) which has been announced by Miethe and Stammreich, and independently by Nagaoka, the change might conceivably be effected either by the entry of an electron into, or by the removal of a proton from, the nucleus of the mercury atom. The same alternatives present themselves in regard to the transformation of lead (82) into thallium (81).

Prof. Nagaoka, in attempting to bring about the transmutation of mercury into gold, designed his experiments with the view of facilitating powerful disturbance of the mercury nucleus which might lead to the ejection of a proton, because considerations of the satellites of the spectral lines of mercury had led him to the conclusion that in this element a proton is "slightly detached" from the central nucleus, and therefore possibly capable of removal. His experiments, which yielded a positive result, do not, however, enable us to distinguish conclusively between the two alternative methods of transmutation.

In Miethe and Stammreich's experiments the arrangement was entirely different, and the gold was obtained from mercury-vapour lamps using a heavy current, but requiring that the potential difference should exceed only 170 volts. In the account of these experiments given in NATURE of August 9, 1924, the possibility of the transmutation being due to the disruption of the mercury nucleus appears to be the only explanation considered; but, as Prof. Soddy has pointed out, an atomic disruption is not necessarily involved, and the alternative of attaching an electron to the mercury nucleus needs to be taken into account. Certainly the nature of the experiment does not preclude this possibility.

In essentials the experimental arrangement employed by Smits was similar to that of Miethe, for it consisted of a quartz lead-vapour lamp of special design run at voltages of less than 100 and with currents up to 100 amps. Smits records that initially the spectrum showed only one of the mercury lines, 2536, and that very weakly, but that after running the lamp for 10 hours the strongest mercury lines in the visible as well as the ultra-violet region of the spectrum had made their appearance, and that the most characteristic thallium line was also visible.

Now in the case of the transmutation of lead (82) into mercury (80), the change may occur either by the intermediate production of thallium by one of the processes already suggested, and the subsequent conversion of the thallium into mercury by a second similar process, or it can occur as a one-stage change by the ejection from the lead nucleus of either one doubly charged positive particle (presumably an α-particle) or two singly charged positive particles (presumably protons) simultaneously. If the process occurs by the intermediate production of thallium, one would expect to find evidence of a relatively large amount of thallium compared with the amount of mercury produced. Prof. Smits does not appear to have found such an effect, for he records stronger evidence of the production of mercury than of the production of thallium.

In the circumstances of Nagaoka's experiments, in which very intense electric fields were employed, it is conceivable that these fields brought about a disruption of the nucleus, and that, as a result, a portion of the nucleus was thrown off. In the cases both of Miethe's experiment and of Smits' experiment, if such a disruption occurs, it must be brought about by a different means. When atoms are bombarded by electrons, it is possible that in a few instances an electron penetrates within the K shell of extra-nuclear electrons, though it is certainly surprising that this is possible in the circumstances of these experiments. When such a penetration does occur, the electron will be attracted towards the nucleus and may possibly be absorbed by it. Even so, in some cases the absorption of an electron by the nucleus may render the latter unstable and disruption may occur with the ejection of a proton and an electron, either separately or together, in which case the final chemical state of the disturbed atom will be the same as if the electron had been absorbed by the nucleus and a stable condition attained.

If we adopt Nagaoka's view that there are "slightly detached" portions of the nucleus, disruption by the approach of an electron is perhaps more easily imagined. Moreover, since lead consists of several isotopes, it is not unreasonable to suppose that the close approach of an electron to the nuclei of different lead isotopes would have different results. It is possible that the production of thallium results from one isotope, and the production of mercury from another.

It must be remembered that if the transmutation of one element into another is brought about by the ejection of some part of the parent nucleus, something corresponding to the final state of the ejected portion must be present to the same extent as the element resulting from the changed condition of the main part of the nucleus of the parent atom. In the cases considered, if the thallium and mercury are produced in this way, one might expect to find hydrogen (or perhaps in the latter case, helium) present to corresponding extents, and it is possible that these might be detected by spectroscopic observations under appropriate conditions.

In the case of transmutation by absorption of electrons into the parent nuclei, one would not expect to find these other elements. It therefore appears that the most hopeful method of obtaining evidence as to the exact nature of transmutations such as those recently recorded is from attempts to detect the lighter products as well as the heavier products of possible transmutations.

A. C. DAVIES.
FRANK HORTON.

Royal Holloway College,
Englefield Green, January 7.

Foreshadowing Elements of Atomic Numbers 75, 85, 87, and 93 by means of X-rays.

IN your columns of Current Topics and Events, Dec. 26, 1925, p. 943, I notice a critical abstract of a series of articles by Dr. Druce and myself, relative to the existence of elements of atomic numbers 75, 85, 87, and 93, which appeared in the *Chemical News*, Oct. 30, Nov. 6, 13, 20, and 27. A later communication in the issue of Dec. 11, 1925, should be included, as reference will be made to it below.

In justification of our work I must state that Film No. 3, which gave us the evidence of the presence of element 75 and meagre evidence of the presence of element 87, is completely ignored in the critical argument in question. Manganese sulphate was used in this case.

The line on which we have attempted to establish element 87 (Film No. 3) is one of wave-length 1·032, a fairly strong line considering the range of exposure; not $\lambda = 1{\cdot}040$, because this line seemed to represent some other element, and in one case it was wide enough to include several lines (λ1·040 was, however, mentioned in this connexion, and I tried to make something of it, as an attempt was made by Dr. Druce to isolate element 87 chemically from pyrolusite, but this substance has, as regards this element, so far proved to be disappointing). On p. 289 of the *Chemical News* we say: "On investigation we find that this line of wave-length 1·032 Å units fell exactly between the theoretical $L\alpha_1$ and $L\alpha_2$ lines of element of atomic number 87. We looked for the $L\beta$ line of this element, but failed to find it, as the bromine-silver absorption bands on the film fell in the region where the line should appear as a very faint one." In the same journal for Dec. 11, 1925, this obscured line was indicated as it was seen by one of Messrs. Adam Hilger's research staff when I was examining the film on one of their spectrum comparators.

Had mercury been present sufficient to give rise to an L radiation, the whole of this radiation would have been excited at the voltage used, and the comparatively strong Hg$L\beta_1$ line would have appeared on the film; whereas, only the lines corresponding to the $L\alpha_1$ and $L\beta_1$ radiations of 75 were present, in addition to those mentioned above of wave-lengths 1·032 and 0·837 (the latter as afterwards approximately determined by means of the spectrum comparator). The three lines were of sufficient strength to stand out well on the film, which was clear and free from fogging and other obscuring effects, except in respect of the Br-Ag absorption region.

Referring to p. 339 (Nov. 27 issue of the *Chemical News*), Film No. 1 was not perfect throughout and the exposure was more on the long wave-length side, but the 1·43 line was clearly revealed. Film No. 2 showed fairly strong lines $\lambda = 1{\cdot}43$ and $\lambda = 1{\cdot}233$, but the range of oscillation was limited to the region where these lines fell. Film No. 3, therefore, afforded a crucial test, for it covered the range below $\lambda = 0{\cdot}837$ to that beyond $\lambda = 1{\cdot}539$. When this film was taken, two other films were consecutively obtained with the same exposure (6 hours) and the same range of oscillation of the crystal and the same setting of the spectrograph. One showed only the copper lines, and it was a perfect film in every way. The other showed only the $K\alpha$ and $K\beta$ lines of both zinc and copper, for a substance containing zinc had been rubbed on the copper anticathode. Two of these sets of lines on their respective films were used to check the 75 $L\alpha_1$ line on one of them by noting the displacement of this line relative to that of the $K\alpha$ line of zinc, using for this purpose the spectrum comparator mentioned above. The copper lines were used for registration in the usual way. This test showed a slight displacement of the line towards the shorter wave-length side relative to that of zinc.

Furthermore, had mercury been the cause of one of our lines in the above tests, the Hg$L\beta_1$ line should have appeared on these three films and the Hg$L\alpha_1$ line as well on the films containing the zinc and copper lines only, but no sign of these lines could be detected. All three films were clear and the copper lines were quite strong, as were the zinc lines in the one case where a zinc compound was placed on the anticathode as stated above.

Films Nos. 4 and 5 were taken, when a sample prepared from pyrolusite was rubbed on the face of the anticathode. Lines $\lambda = 1{\cdot}086$ and $\lambda = 0{\cdot}895$ were obtained corresponding very closely with the $L\alpha_1$ and $L\beta_1$ lines of element 85, which we commented upon thus: "They are too ill-defined for us to establish their identification with this possible element." Pyrolusite samples have so far given a number of lines we could not identify. In two cases "93" appeared to be foreshadowed, but we dismissed this matter in the following terms: "The last element of all, of atomic number 93, was discussed in our first communication . . . the possibility of this element existing having stimulated our research from the start. There is some evidence of its existence, but to be critical, the line 0·693 comes near to the limit of the region explored by the setting (oscillation) of the rocksalt crystal of the spectrograph, and edge effects are possible here. At any rate this may account for some of the extreme 'lines' given at the foot of columns 12 and 13"—p. 340, *loc. cit.* It is true another likely pair of lines of wave-lengths 0·888 and 0·897 appeared on another film, but we still hold the same view that 93 is too imperfectly foreshadowed to be seriously considered. The calculated wave-length of the $L\alpha_1$ line of 93 I find to be 0·8877.

With regard to the brass of the apparatus giving rise to a zinc line, Messrs. A. Hilger, Ltd., say no such line ever appeared on their films except in the case of the tungsten target, which has a brass overlapping edge that holds the target in place.

Referring to the last remark in the note in NATURE, this, in my opinion, is uncalled for, since we have placed all the cards on the table, and then say in effect "that the research we have started on the missing elements in, or in connection with, Group VII., is promising and the work is being continued." All the quotations are from our own writings as listed at the opening.

In conclusion, I only regard 75 and 87 as identified by means of X-rays, and these, so far as published, from manganese sulphate, and not from pyrolusite. Pyrolusite gives lines difficult to identify, but with manganese sulphate all the proper lines were, in my opinion, identified.

As regards the confirmatory evidence from Dr. Druce's chemical side of this research I instigated, this might be mentioned, but I must leave the chemical side to my colleague.

F. H. LORING.

WE have carefully examined Mr. F. H. Loring's part in six contributions as published in the *Chemical News*, and also the above communication, all in respect of the X-ray side of the research, and we have pleasure in stating that Mr. Loring has correctly transcribed our measurements, and the statements made as coming from us are correctly so described.

ADAM HILGER, LTD.
F. TWYMAN (Manager).

THE position taken up in the note to which Mr. Loring's letter refers was that the X-ray evidence was insufficient definitely to establish his claims. Experience with apparatus similar to that used by Mr. Loring shows that the difficulty is not one of obtaining foreign lines but of eliminating them. Unless special precautions are taken, prolonged exposures give lines due to various sources in addition to those corresponding to the radiations from the anticathode. Two of the most common sources are zinc and mercury. If the exposure and conditions are such as to permit of the detection of small quantities of any element in the anticathode, then the zinc line must appear from the passage of the X-rays through the brass slit of the spectrometer and probably also from the brass of the tube itself. If we accept Mr. Loring's view that the line 1·43 is not the zinc $K\alpha$ line, then the necessary conclusion is that he could not hope, under the conditions of his experiments, to detect small quantities of elements in the material under investigation. The photograph to which reference was made in the note was made for the purpose of that note and showed both zinc and mercury lines.

Mr. Loring states that a comparison of the line 1·43 with the zinc $K\alpha$ line obtained on another film showed a slight difference in position between the two. It is possible to suggest various explanations for such a shift based on purely geometrical considerations, but a critical discussion of the point is impossible until a detailed account of the experimental arrangements is published. A better test would be to obtain both lines on the same plate. If the amount of element No. 75 present is so great that the $L\alpha_1$ and $L\beta_1$ lines appear with exposures insufficient to bring up the zinc line, then it should be relatively easy to obtain also the γ_1 line, which lies well outside the bromine absorption band.

The results claimed by Mr. Loring are so important that the X-ray identification of the lines should be placed beyond doubt, and this cannot be said to be the case until a satisfactory explanation is given of all the lines found on the films, and not merely of a selection of them, as has been done up to the present.

THE WRITER OF THE NOTE.

Genes and Linkage Groups in Genetics.

I FIND it a little difficult to deal with Prof. MacBride's reply to my letter, in NATURE of December 26, since it seems to me not to take any account of the numerous facts bearing on the point which I raised. I feel that the only course is very briefly to enumerate the chief of these facts, and leave other biologists to judge if Prof. MacBride is right in his strictures, or in his views of linkage. I do this at the risk of becoming tedious, because it appears to me very unfortunate that, when delicate quantitative methods are at length introduced into a difficult biological field, they should be attacked on what I consider wholly insufficient grounds by prominent authorities such as Prof. MacBride.

As I see them, the facts are these: (1) There are numerous pairs of characters of organisms which "breed true" and which, when the strains showing them in pure form are crossed, reappear in the F_2 generation in the ratio 3 : 1. This has universally been taken to indicate material *somethings* in the germ-plasm connected with the appearance of the characters in question, and segregating in a clean-cut way into the F_1 gametes—in other words, *genetic units.* These doubtless are "disturbances of the chromosomes," but they are equally genetic units, and we may continue to use the non-committal term *factors* for them.

(2) When two such pairs of factors (call them A and *a*, B and *b* respectively) have been separately identified in a species, we can then test them together in one experiment. If so, it is without exception found that one of two things will happen:—

(2*a*) However the factors are introduced into the cross, the results in all later generations are the same. The F_2 gives the ratio 9AB : 3A*b* : 3*a*B : 1*ab*, the back-cross to the double recessive the ratio 1 : 1 : 1 : 1. This has been universally taken to imply *independent segregation* of the two factors.

Or (2*b*), the result is different according as to how the characters are introduced into the cross. Taking, for simplicity's sake, only the result of back-crossing F_1 to the double recessive, then (i.) if the cross was AB × *ab*, we get *n*AB : 1A*b* : 1*a*B : *nab*, where $n > 1$. (ii.) If the cross had been A*b* × *a*B, precisely the *reverse* result occurs, namely, 1AB : *n*A*b* : *na*B : 1*ab*, *n* having the same value as before. This has been universally taken to indicate genetic linkage (some degree of absence of independence) between the two factors. (iii.) In Drosophila there is the further fact that the results under (i.) and (ii.) differ according to the sex of F_1. The female gives the formula stated above, but the male, without exception, gives *n* infinite—*i.e.* linkage is complete in the male. How these facts bear any relation to Prof. MacBride's definition of linkage, I fail to see. The same factors in the same proportions are present in F_1 in both (i.) and (ii.), and in male and female under (iii.); yet the proportions of the normal type and what Prof. MacBride regards as the doubly pathological type (with both mutant characters) are entirely different in accordance with the way in which the factors entered the cross, and with the sex of the individual tested. That this reversal of proportions can have anything to do with the weakening of developmental energy of which Prof. MacBride speaks as the basis of linkage, is to me unintelligible.

(3*a*) Finally, we can define as the "percentage cross-over value" (N.B., *pace* Prof. MacBride, as a purely genetic concept, with *no reference* to possible cytological interpretation) the expression $\frac{100}{n+1}$.

(3*b*) If by the methods of (2*b*) above, A or *a* has been found to be linked with B or *b* with cross-over value *p*, and with C or *c* with cross-over value *q*, then it can now be prophesied that on testing B or *b* with C or *c* (α) linkage will be found between them; and (β) if *p* and *q* are small, the cross-over value will be the algebraic sum of $p \pm q$.

This prophecy has been repeatedly verified; and no exceptions occur to the rule, provided naturally that conditions are kept constant, as in any physical or chemical experiment. It is on this last general result that the hypothesis of linear arrangement of the factors is based. I can only repeat that if Prof. MacBride can advance any alternative explanation of these facts (which he has not yet done), it will be of great interest.

With regard to points in Prof. MacBride's reply, he is not accurate in stating that Jennings started by assuming chromosome-breakage. Jennings assumed nothing but the facts provided directly by certain breeding experiments—namely, the proportions of certain visible characters appearing after certain crosses. The genetical fact that linkage is broken in a regular percentage of cases is entirely independent of any cytological hypothesis advanced in further explanation of it; and I repudiate the suggestion that to state this is to show confusion of thought. I have tried hard to grasp Prof. MacBride's own definition of linkage. He states that the basis of a linkage-group is "an impairment . . . [of] 'developmental energy'"; in other words, if I understand him aright, a kind of constitutional disease. Further, each of its constituent "factors" is a "symptom" of this diseased state. Hence, I take it, *Drosophila melanogaster* is afflicted with 4 of these constitutional diseases, of varying severity, since some exhibit many more "symptoms" (factors) than others. *D. obscura*, on the contrary, suffers from 5 such "diseases," and *D. virilis* from 6. Whether the greater intensity of linkage in the males indicates a greater severity of affection, I do not gather. I repeat that this is the only meaning that I can extract from his words; if I am mistaken, I apologise. Prof. MacBride also states that a unit-factor is a *change*, which to me is unintelligible. He also indulges in some speculations about the origin of mutations. This, however, has nothing to do with the point I raised, namely, the distribution of segregating factors, by whatever means originated, among the gametes.

Neither are the beliefs of Dr. Bateson or of Prof. Johannsen at issue. "What the policeman said is not evidence" holds good for science as well as for law. The facts alone concern us, and I have tried to confine myself to such simple facts as with the aid of half-a-dozen stocks of Drosophila could be easily imparted by practical demonstration to a class of undergraduate students, and are regularly so demonstrated in numerous American universities.

J. S. HUXLEY.

King's College, London.

A Metastable *P* Term in the Manganese Arc Spectrum.

THREE years ago Wentzel (*Phys. Zeit.*, 24, 104, 1923) pointed out that a metastable state of the manganese atom was to be expected and as evidence of this directed attention to a fivefold *D'* term. So far as the author is aware, *P'* terms in this spectrum have never been identified although they also should be expected.

In a letter to NATURE by Mr. Beese and me (December 26, 1925, p. 936) attention was directed to the fact, noticed by me, that in many spectra the frequency of the first *pp'* group is near to the difference of frequency between the two lowest energy levels in the same system, both in the spectrum concerned and in the spectrum of the once more ionised atom.

Dr. R. V. Zumstein, National Research Fellow at the University of Michigan, has kindly pointed out to me a group of six lines in the manganese spectrum. During Dr. Zumstein's researches on absorption in the spectrum of manganese (to appear in the *Physical Review*) these lines were found to be reversed in a heavy manganese arc but not absorbed by heated manganese vapour. These lines, therefore, must arise from low-lying energy levels in the atom but not from the normal state. Three of the lines were tentatively designated by Catalán (*Phil. Trans.* 223 A, 127, 1922) as the fifth triplet of the sharp series in what is now known to be the octet system. However, the intensities of these three lines are not in the usual order and are much too great for this assignment. The reversal of these lines in the heavy arc, while the other triplets of the sharp series are not reversed, makes it certain that Catalán's assignment is incorrect.

The above-mentioned group of six lines satisfied the relation pointed out in the first paragraph for the location of the *pp'* group, and, on examination, these six lines are found to form a normal *pp'* group. The data are given in Table I. The principal narrow triplet is the first triplet in the sextet principal series. The first triplet in the septet system of ionised manganese is seen to be actually entwined with the *pp'* group. The *pp'* group is seen to be normal in structure. The behaviour of these lines in the arc and absorption as described above is in accord with their assignment as a *pp'* group. The Zeeman pattern has apparently never been determined for this group of lines. However, there seems little room for doubt that these lines are a *pp'* multiplet in the octet system of Mn I, involving a metastable threefold *P* term. Since the *pp'* frequency is so near $^7S_3 - {}^7P_4$, the limit of the $^8P'$ terms must correspond to an ionised manganese atom excited in a ^7P state.

TABLE I.

PP' GROUP IN MANGANESE I.

Principal Narrow Triplet, Mn I $\nu =$	35769·4 725·82 690·07
PP' Group . . . . $\nu =$	38512·7 554·5 683·4 686·4 815·6 857·1
Principal Triplet, Mn II . $\nu =$	38366·03 542·94 806·52

		2592·95 (5) 38554·5			P_0'
		131·9			
2595·77 (4) 38512·7	*173·7*	2584·12 (3) 38686·4	*129·2*	2575·51 (5) 38815·6	P_1'
170·7		*170·7*			
2584·32 (4) 38683·4	*173·7*	2572·77 (5) 38857·1			P_2'
P_2		P_1		P_0	

RALPH A. SAWYER.

Physical Laboratory,
University of Michigan,
Ann Arbor, December 5.

"Alchemistische Decknamen."

IN their recent paper under the above title (*Sitzungsber. d. Phys.-Med. Sozietät*, Erlangen, Bd. 56, pp. 17-36, 1924) Profs. Wiedemann and Ruska used (among others) the Dresden MS. 210, which contains a list of "Decknamen" for iron, copper, tin, lead, mercury and sal-ammoniac, twenty-four for each substance. It may be worth recording that a list so similar as to point to a common origin occurs in the British Museum MS. *Add.* 25724, ff. 15 *verso*-17 *recto*. This gives 24 names each for iron, copper, sulphur, tin, lead, mercury and sal-ammoniac, so that it affords a check upon Wiedemann and Ruska's list in the case of the six bodies mentioned, and supplements it with the names of sulphur, which are missing from the Dresden MS. The two MSS. agree in being anonymous, while the caption at the head of the list in the Dresden MS. is identical with that in the Brit. Mus. MS.

i. *Iron.*—Names 1-5 and 7-24 are the same in both lists. The Dresden No. 6, *al adqār*, is replaced by *al-ashqar* ("the ruddy") in the Brit. Mus. MS. The latter reading appears to be preferable; I find no authority for Wiedemann and Ruska's translation of *adqār* as "Fuchsfarbige."

ii. *Copper.*—The two lists agree in all 24 names, except that the Brit. Mus. MS. reads *nāwūs* (sarcophagus) for *ṭāwūs* (peacock). It is difficult to say which is the more probable reading, though the characteristic colours of copper salts tend to favour *ṭāwūs*.

iii. *Tin*.—All the names are identical with the exception of Nos. 11 and 22. For the former, Wiedemann and Ruska read "*al qāṣirī*, das Mangelhafte." The Brit. Mus. MS. reads *al-qāḍī*, *i.e.* the judge, which is far more probable, especially as *qāṣirī* is apparently quite unknown to Arabic lexicographers. For No. 22, Wiedemann and Ruska give "*al absīmat al ḥaǵar* (unverstandlich; *basīmat al ḥaǵar* Lächeln des Steins [der Weisen] ?)." The Brit. Mus. MS. reads *ḥajar al-ishmīth*, *i.e.* the stone of *ithmid* or antimony sulphide (*kuḥl* or στίμμι).

iv. *Lead*.—The two lists agree in the main. Dresden No. 11, however, is given as *al sarzīn* (Wiedemann and Ruska:—"wohl verdorbenes persisches Wort"). The Brit. Mus. MS. reads *al-razīn*, "the heavy, ponderous." Dresden No. 17 reads *al baḥs*; this appears to be a misprint for *al-naḥs*, since Wiedemann and Ruska translate the word correctly as *Schaden*. Dresden No. 18 reads *aḥraṣ*, rightly emended by Wiedemann and Ruska to *aḥras*, the Brit. Mus. reading.

v. *Mercury*.—Perfect agreement between the two lists.

vi. *Sal-ammoniac*.—Dresden No. 1, *al mukram*; Brit. Mus., *al-karam*. The former is preferable. Dresden No. 23 is "*al kajjis*, der intelligente"; the Brit. Mus. MS. reads *al-layyin*, "the soft," which is clearly correct. Dresden No. 24 is the same as No. 22 ("*ṣābūn al ḥukamā'*, Seife der Gelehrten"), Brit. Mus. No. 24 reads *shams al-ḥukamā'*, *i.e.* the sun of the sages.

vii. *Sulphur*.—Absent from the Dresden MS. The British Museum MS. reads as follows:—1. Quite definitely *al-lat'ī*, which is unintelligible. It may be a mistake for, or a modification of, *al-latha*, the gum or resin. 2. *al-wāqid*, the burning. 3. *al-'aqrab*, the scorpion. 4. *al-muḥriq*, the inflammable. 5. *al-nār*, the fire. 6. *al-aṣfar*, the yellow. 7. *al-sham'*, the wax. 8. *dhū al-janāḥīn*, the winged. 9. *al-ṣab'*, the indicator; but it is likely that a diacritical point has been omitted and that the true reading is *al-ṣabgh*, the dyer [*sc.*, of metals]. 10. *al-'arūs*, the bride. 11. *al-ṣamgha* (although there is no diacritical point over the '*ain*), the gum. 12. *al-khiḍāb*, the dye. 13. *al-zuḥār*, the moaner (possibly because of the crackling of a lump of sulphur when held in the hand). 14. *al-ṭalq*, the talc (mica, gypsum). 15. *al-dhahabī*, the golden. 16. *al-'alam*, the sign. 17. *al-bayraq*, the flag. 18. *al-jabal al-aṣfar*, the yellow mountain. 19. *al-ḥajar al-muṣaffaḥ*, the smooth stone. 20. *al-mubayyiḍ*, the whitener. 21. *al-musawwid*, the blackener. 22. *al-mulayyin*, the softener. 23. *zandarīkh*, sandarach. 24. *al-ḥimār*, the ass (or, since the first vowel is uncertain, the word may possibly mean "the redness." *Cf.* Dozy, *Supplément*, *sub voce*).

E. J. HOLMYARD.

Clifton College, Bristol,
December 23, 1925.

Maori Rock-Carvings.

IN NATURE of November 21 last, p. 763, reference is made to an interesting discovery of Maori rock-carvings announced by the Wellington (N.Z.) correspondent of the *Times* in its issue of November 11. In that account there occurs the following passage: "Further exploration in this region [the Ngatihotu country] it is hoped may yield . . . possibly even a picture of a Moa which would establish the connexion of the Maoris or their predecessors with this great wingless bird. . . . Some authorities consider that the Moa was extinct before the first Maori migration, though it is admitted that the people who were here before the Maoris saw the bird in the flesh."

In the year 1889 it fell to me to explore the Sumner cave near Christchurch (N.Z.). The cave was concealed by a landslip (probably due to an earthquake) which had occurred before the colonisation of Canterbury Province. Its existence was quite unsuspected until the quarrying for road-mending of the stone supposed to be continuous with the live-rock of the hill of which it formed the fore-front, which had been going on for many years, suddenly broke into it. On crawling in as soon as the orifice permitted, I found on the floor of the cave—a cavity fit to shelter a score of people perhaps—a fire-place with half-consumed wood projecting radially from it in an undisturbed position, just as left by the occupants who had hurriedly escaped, leaving their fire alight until it had burned out. They were evidently fisher-folk, for they left behind them fish hooks, net sinkers, paddles, numerous lengths of fishing-line of plaited human hair, and in their kitchen-midden broken shells, bones of seal, dog, Moa (partly burned, partly broken), and of other bird bones, among them those of an extinct species of swan (*Chenopis sumnerensis*) unknown to Maori tradition.

Evidence more important to the question being here considered, however, I found lying around the fire-place and in other parts of the cave, in the form of Moa egg-shells so disposed as to leave little doubt that their contents had been partaken of as a meal. Such portions of these shells as had not suffered by the fire still retained their internal membrane, indicating that the eggs when gathered were still fresh—or sufficiently so. Other objects obtained from the cave were a boat-bailer with quite characteristic Maori ornamentation, a carved curl-tailed dog (? head of a paddle), a tiki, one or two other greenstone objects, and a few obsidian flakes. The cave-deposit consisted of sterile strata separated by well-marked hearths containing charcoal, shells, and fragments of bone, indicating an intermittent occupation of very long duration. The fall of material from the roof had been extremely slow since the closure of the cave, for the bailer, which lay on the surface hollow up, was practically empty. The occupants of the cave, as identified by their cultural objects, must be held to be of the same race as the present natives—unless the pre-Maoris practised a similar style of carving and of greenstone manufacture—and were obviously acquainted with the living Dinornis.

The contents of the cave were placed in the Canterbury Museum, Christchurch, of which I was then Director, and a hasty preliminary account appeared in the *Transactions of the New Zealand Institute* for 1890, less detailed, however, than the contemporary record, with photographs, preserved in my journal. My departure from New Zealand and multifarious imperious duties since have prevented the publication of the fuller details. I hope, however, with continued improvement in health, to make good my default shortly.

HENRY O. FORBES.

Luminous Leaves and Stalks from Bengal.

PROF. BULLER, of Manitoba, Winnipeg, in his "Researches on Fungi," vol. 3, published in 1924, states on p. 426 that he is now able to affirm that luminous leaves, in addition to occurring in France, Germany and Java, as reported by Tulasne in 1848 and Molisch in 1904, also occur in England, Canada, and the United States; and that as time goes on, doubtless many other countries will be added to this list.

In July last I obtained a collection of decaying leaves, small pieces of dead wood, living grass roots and stalks, living fern petioles, and living roots of

Averrhoa Carambola, giving out a distinct soft white light, from a covering of forest bed in Barisal in Bengal. Four years back I got a similar collection of luminous leaves, wood, etc., from the Bikrampur district in Bengal. In most cases I could find a colourless fungus-hyphæ in their sections. Luminosity was usually confined to certain spots only, while in some cases thin flat surfaces were luminous all over. Stalks showed a white streak of light along their lengths; no particular tissues within the stalks could be located as luminous.

Molisch attributed the cause of luminosity to fungi in decaying leaves, but so long as the fungus is not isolated and brought under pure culture so that its identity may be established, the point is not free from doubt. Molisch holds that the fungus gives out a photogen which, coming in contact with oxygen and water, gives out light; it is a process of slow chemical combustion without production of heat. But the photogen cannot be extracted. When I began crushing those luminous specimens with pestle in mortars containing a little cold and hot water in a dark room, the luminosity failed altogether, showing that photogen is not an extracellular secretion or excretion, but is bound up inseparably with the protoplasm of the living hyphæ—so long as the fungus is in a living condition it continues to emit light. The response of the light-giving substance in this case was in every way similar to that of a living one, namely, when I put those luminous specimens in a receiver and supplied them with a current of pure oxygen, they glowed more intensely than before. Light diminished on passing currents of pure hydrogen, nitrogen, and carbon dioxide gas, the former luminosity reappearing on access to the oxygen of the air. Putting specimens in a vacuum-bath and using an air-pump the light failed, but as soon as air was let in, the former condition of luminosity revived at once. Luminosity increased when specimens were immersed in dilute solution of hydrogen peroxide. Luminosity failed permanently on dipping the specimens in strong alcohol or chloroform, thus showing that if the fungus is somehow killed, there can no longer be the production of photogen.

The present lot of specimens remained luminous for about ten weeks, being kept in a moist condition. Specimens lose their luminosity when in a dried condition in blotting paper, but revive partially when in contact with water.

I could develop a photographic plate by exposing the film side to the direct action of a luminous stalk for nearly 48 hours, keeping a control.

S. R. BOSE.

Botanical Laboratory,
Carmichael Medical College,
Calcutta, November 26.

The Origin of the Satellites in the Ultraviolet OH Bands.

IN a letter in NATURE of February 7, 1925, p. 194, G. H. Dieke suggests that the numerous satellites in the ultraviolet OH bands originate in the same quantum states of the molecules as do the main lines. The test of this supposition is to see whether or not these faint lines are additional combinations between the same terms which are given for the principal lines, but sufficiently precise measurements for the application of this criterion have not been available. I have therefore remeasured the λ3064 band, using a high dispersion plate (1·3 Å.U. per mm.) on which this band was strongly developed, the main lines being necessarily over-exposed in order that the satellite system be well brought out.

The following "satellite" Q_1 and Q_2 series which, if combined with the main P and R lines, satisfy the combination relation $Q(m) - P(m+1) = R(m) - Q(m+1)$, have been located. They must, then, have the same final rotational state as the P and R branches, and so can be represented by the term formulas $F_1(m) - f_1(m)$ and $F_2(m) - f_2(m)$ respectively. Vacuum wave numbers are given, and unresolved doublets are denoted by *.

m.	$\sigma Q_1(m)$.	$\sigma Q_2(m)$.	m.	$\sigma Q_1(m)$.	$\sigma Q_2(m)$.
9	32283·74	32333·38*	18	31915·75	31944·36*
10	256·97	300·21	19	851·91*	885·41
11	226·49*	269·28	20	794·18*	820·96
12	192·24	231·48*	21	723·29	752·77*
13	154·69	192·24	22	653·88	683·42
14	113·27	149·53	23	577·50	604·27
15	070·55*	104·49	24		528·05
16	022·50*	053·50	25		439·38
17	1969·84				

It seems probable that most of the remaining satellites can also be represented by combinations between the terms in the main branches.

The same combination defect, $Q(m) - P(m+1) = R(m) - Q(m+1)$, which exists in these OH bands is also present in the magnesium hydride bands.[1] In view of the general similarity between the two band systems—both having the same characteristic spreading of the doublets near the band origins—it is reasonable to assume that the MgH bands, too, owe their combination defect to the existence of displaced Q levels. Satellite lines also exist in the MgH bands, but their investigation is obstructed by the presence of the many faint isotope lines.

These additional energy-levels have not as yet received interpretation in the theory of band spectra. More quantitative results such as the above would be a great aid in the solution of this problem.

The word satellite as used in this connexion, however, is somewhat of a misnomer, since, for example, $Q_2(24) - \sigma Q_2(24) = 2 \cdot 1$ Å.U., with five other lines falling in this interval.

WILLIAM W. WATSON.

Ryerson Physical Laboratory,
The University of Chicago,
December 22, 1925.

The Crystal as Diffraction Grating.

THE use of a crystal as a grating for measuring the wave-lengths of Röntgen rays affords a beautiful illustration of the value of a second reference frame that may be associated with the customary reference frame of vector analysis. Let $\mathbf{e}_1 \ \mathbf{e}_2 \ \mathbf{e}_3$ be the prime vectors of the customary frame. The second or derived frame, the prime vectors of which we will denote by $\mathbf{e}^1 \ \mathbf{e}^2 \ \mathbf{e}^3$ with superior affixes, is such that the scalar products $\mathbf{x}.\mathbf{e}_1 \ \mathbf{x}.\mathbf{e}_2 \ \mathbf{x}.\mathbf{e}_3$ of any vector $\mathbf{x}$ and the original prime vectors are the cartesian components of the vector in the derived frame, and the scalar products $\mathbf{x}.\mathbf{e}^1 \ \mathbf{x}.\mathbf{e}^2 \ \mathbf{x}.\mathbf{e}^3$ of the vector $\mathbf{x}$ and the derived prime vectors are the cartesian components of the vector in the original frame.

Because of this property we use $x^1 \ x^2 \ x^3$ with superior affixes to denote the components of $\mathbf{x}$ in the original frame, and $x_1 \ x_2 \ x_3$ for the components in the derived frame, so that with the usual convention as to the summation of affixes we write

$$\mathbf{x} = x^a \mathbf{e}_a = x_a \mathbf{e}^a$$

In a crystal of any form we take the origin at a point occupied by an atom, and for the heads of the

[1] W. W. Watson and P. Rudnick, *Astroph. Journal*, January 1926. That these bands have as their carrier the MgH^+ ion is shown by several independent lines of evidence.

prime vectors e_1 e_2 e_3 we take three adjacent non-coplanar atoms. Let unit vector r give the direction of the incident ray and unit vector s that of the emergent ray. The conditions for the reinforcement of an emergent ray of wave-length λ are

$$s_1 - r_1 = m_1\lambda \quad s_2 - r_2 = m_2\lambda \quad s_3 - r_3 = m_3\lambda \qquad (1)$$

where m_1 m_2 m_3 are integers.

We take a vector m the components of which in the derived reference frame are the integers m_1 m_2 m_3 so that

$$\mathrm{m} = m_1\mathrm{e}^1 + m_2\mathrm{e}^2 + m_3\mathrm{e}^3$$

Equations (1) are then all included in

$$\mathrm{s} - \mathrm{r} = \lambda\mathrm{m} \quad . \quad . \quad . \quad . \qquad (2)$$

From this we have

$$\mathrm{s}.\mathrm{s} = (\mathrm{r} + \lambda\mathrm{m}).(\mathrm{r} + \lambda\mathrm{m})$$

or

$$2\mathrm{r}.\mathrm{m} + \lambda\mathrm{m}.\mathrm{m} = 0 \quad . \quad . \quad . \qquad (3)$$

the equation that gives the wave-length.

The directions of the incident and emergent rays make the same angle with the vector m and this might be called the incident angle. The glancing angle θ, which it is the custom to measure, is the complement of the incident angle, and is the angle made with the mesh planes perpendicular to m. It is given by

$$\cos 2\theta = \mathrm{r}.\mathrm{s}$$

which by the help of equations 2 and 3 becomes

$$\sin\theta = \frac{\lambda}{2} \text{ times the magnitude of vector m.}$$

When m_1 m_2 m_3 are prime to one another, the distance d between successive mesh planes is the reciprocal of the magnitude of m, so that

$$\sin\theta = \frac{\lambda}{2d}$$

The derived reference frame is equally appropriate in three dimensions and in four. D. B. MAIR.

January 11.

Weather Prediction from Observation of Cloudlets.

MR. CAVE writes: "I am not sure that I understand the second of Sir Archdall Reid's definitions of cloudlets—'small diaphanous clouds that can be seen at the same time in every part.'" The preceding definition was "the smallest and thinnest fragment of cloud that can be clearly isolated." I do not know how to express myself more plainly. On the other hand, Mr. Cave and I may not mean the same by "cumulus" and "cirro-cumulus." If there be any difference, then, since I am a mere amateur, I am sure he is right. I can only say that my suggestion as to the utility of observing cloudlets is founded on many years' experience, and, so far as I can judge, on common sense. To me it appears true (1) that rain is preceded by the condensing of clouds, and a return of fine weather by their dissolving; (2) that when clouds wax visibly rain is probable, and fine weather when they wane swiftly; (3) that, in proportion to their sizes and densities, the waxings or wanings of big clouds are difficult to observe; (4) that, in proportion to their smallness, thinness, and isolation, the behaviour of cloudlets is easy to observe; and (5) that the behaviour of cloudlets is usually an index of the behaviour of neighbouring clouds, and therefore of current atmospheric conditions. I find it hard to believe that clouds *commonly* change their behaviours so rapidly "that the method is scarcely of more use than the tossing of a coin."

It may be, as Mr. Cave says, that "Lenticular cirro-cumulus is composed of cloudlets that are born on the windward side and die on the leeward side of the cloud mass"; but, if so, the fact puzzles me. I can understand why a cloud should condense on the windward side of a cold mountain peak and dissolve to the leeward. I can understand that a cloud may grow on its cold shadowed side while dissolving on its sunlit slopes—though, because of the difficulties of observation, I have never seen this phenomenon. But I cannot understand how wind can so affect cirro-cumuli that they grow to windward and dissolve to leeward. Are not these cloudlets *in* the wind (and therefore, in a sense, *out of it*) like plums in a pudding? This phenomenon also I have not seen: or at least have not connected with the wind. However, this is not a matter for the "likes of me" to theorise about. The fact remains that any one, at any time, on any day, when cloudlets can be isolated, may test, in a few seconds, the utility of weather prediction by means of cloudlets. I think, like Dr. J. W. S. Lockyer, he will find it useful. I wonder whether Dr. Lockyer can remember whether the rapid growth of his cloudlets usually presaged rain, and their dissolution fine weather? May I insist once more that I have only sought to indicate what seems to me an easily observed and exceptionally reliable weather sign?

G. ARCHDALL REID.

January 12.

Rate of Growth of Fungus Rings.

MR. O. G. S. CRAWFORD's letter in NATURE of December 26, page 938, concerning the age of fairy rings, seems to warrant a letter for publication in addition to a more detailed private letter.

Fairy rings have been objects of interest from very early times and are the subjects of myths in most civilised countries, and are not beneath the notice of writers from Shakespeare to Kipling. As diverse as the myths are the suggestions regarding their mode of formation, ranging from fairy feet to fiery dragons and from thunder to moles.

It is now common knowledge that the rings are the result of a perennating fungus-mycelium and not of an annual spore discharge and germination. It is sometimes alleged that rings may remain stationary for several years; W. G. Smith stated that he knew a fairy ring of *Clitocybe geotropa* on Dunstable Downs which had remained much the same size for forty or more years. Most observers, however, agree that normally the rings increase in size. The rate at which the mycelium extends outwards varies considerably and is apparently dependent on weather conditions. There have been few actual measurements. Thomas studying rings of *Hydnum suaveolens* over a period of nine years found an average annual increase of 23 cm. Ballion records an increase of 12 cm. in one year for *Marasmius oreades*, but the advance was irregular being apparently more rapid when the ring was young, whereas for *Psalliota arvensis* the average increase was more than 50 cm. Bayliss with *Marasmius oreades* found the minimum annual increase to be 3 inches, the maximum 13½ inches. Shantz and Piemeisel estimated the average yearly advance as 12 cm. for *Agaricus tabularis*, and calculated certain Californian rings to be about 250 years old, and a number of small fragmentary rings which apparently had a common origin as approximately 600 years: the largest ring of *Calvatia cyathiformis*, with an average annual increase of 24 cm., was more than 400 years old.

It is obvious that the rate of advance depends upon the species of fungus concerned, and also upon conditions of environment which necessitates observations over a number of years.

It may be remarked that Prof. Buckman mentioned rings on Salisbury Plain more than fifty feet in diameter. J. Ramsbottom.

British Museum (Natural History),
London, S.W.7, January 7.

On the Structure of the D_3 Line of Helium.

Due to the position of helium in the periodic table, relative to that of the alkaline earth metals, it has been frequently pointed out that its spectrum should consist of systems of singlets and triplets instead of the observed singlets and doublets. An unsuccessful attempt has been made to resolve the strong component of the doublet into the two expected components with the expected separation of approximately 0·17 Å.U., since the separation of the observed components is 0·34 Å.U. approximately.

A helium discharge tube wrapped in cotton which was kept wet with liquid air was used as a source, and the light was resolved by means of a quartz Lummer Gehrke plate and a small quartz spectrograph. Fortunately, the dimensions of the plate were such that one order fringe of the main component almost coincided with the next order fringe of the observed component. These together produced a single fringe of width about 1/5 the total distance between the fringes. The component looked for under these conditions should occur half-way between fringes.

Careful examination of the fringe system by both of us failed to reveal any trace of the expected component, though it would have been observed had its intensity been equal to or greater than 1/40 that of the main component of this line and its separation from the main component greater than 0·08 Å.U. Thus it appears that the structure of the $(1\pi - m\delta)$ series of helium does not correspond to the equivalent series of the alkaline earth metals, calcium, etc.

W. A. MacNair.
W. H. McCurdy.

Johns Hopkins University,
Baltimore, Md.,
December 20, 1925.

A Possible Origin of Petrol-Fields.

It has frequently been suggested that natural mineral oils may be the product of decomposed fish. One of the main objections to this explanation has always seemed the difficulty of accounting for the concentration of oil deposits within the comparatively restricted areas in which they actually occur. But if one considers the migration of certain fish, for example the common eel, this objection can, in the main, be overcome.

It has now been definitely established that all the European eels make their way to a certain deep-sea area in mid-Atlantic, where they spawn. The mature eels do not seem to return after spawning, only their offspring appearing in the rivers in due course in vast numbers. If, as is probable, they die after reproduction, there must be enormous deposits under their spawning grounds, which might eventually be in part converted into oil.

The quantities involved in this hypothesis appear to be in no way unreasonable. If one allows a period of say 10^6 years for the formation of the United States oil-fields, which are estimated to have contained two to three thousand million tons of oil, and if one assumes that one eel on an average would provide 100 gm. of oil, then to account for these deposits one would have to postulate an annual migration to the spawning ground of only 2 to 3 million eels. Thus even if the time and the yield have been overestimated by a factor of 10, there would still be a comfortable margin.

A. F. Lindemann.

Sidholme, Sidmouth,
January 12.

Measurement of Radiation Intensities by Photographic Methods.

Referring to Dr. F. C. Toy's letter, under the above heading, in Nature of January 16, p. 83, Dr. John S. Anderson and I came to the same conclusion in an investigation published in the *Proc. Roy. Soc. Edin.* fourteen years ago. In the words of this paper, "Only when two beams of light of the same wave-length fall on adjacent parts of the same photographic plate and produce equal blackening in the same time can we say that their intensity is equal." This principle was made the basis of all the work we did at that time on ultra-violet spectrophotometry. But there are some fields, such as astrophysics, where it cannot be applied.

The object of this letter is to direct attention to the simple method we used for cutting down the intensity of the stronger beam. Half the slit of the collimator was illuminated by the light of an iron arc, and in the line between the slit and the arc travelled a ground quartz diffusing screen. The rays from the quartz screen filled the whole object-glass of the collimator. The intensity of illumination of the half slit varied consequently as the intensity of illumination of the ground quartz, and the latter varied inversely as the square of its distance from the arc. I have since used intermittent sectors and "neutral" absorbing screens which Dr. F. C. Toy favours, but am still of the opinion that for reducing the strength of the beam the inverse square law is preferable.

R. A. Houstoun.

Natural Philosophy Department,
University, Glasgow.

The Occurrence of Dwi-Manganese in Manganese Salts.

From our respective communications (Nature, vol. 116, p. 782; *Chem. News*, vol. 131, p. 273, etc., 1925) it was apparent that, although working on different lines, we had detected the element of At. No. 75 in manganese salts. A sample brought by one of us to Prague has been examined in the laboratories of the Charles' University. The sample was obtained from a solution of "pure manganese sulphate" by removing as much manganese as possible with hydrogen sulphide. When examined polarographically and also spectroscopically, it showed a similar content of dwi-manganese, namely, one per cent. The chemical properties of this mixture agreed with those previously announced from this University. Since we have reached the same conclusion by independent chemical and electrochemical methods, we consider the association of dwi-manganese with manganese as proved, and thus regard the name dwi-manganese (D) as most appropriate for the element At. No. 75.

V. Dolejšek.
Gerald Druce.
J. Heyrovský.

The Institute for Experimental Physics
and Institute for Physical Chemistry,
The Charles' University, Prague,
January 12.

The Advancement of Engineering in Relation to the Advancement of Science.[1]

By Prof. A. E. KENNELLY, Harvard University.

THE term engineering is employed with many different shades of meaning. Tredgold's famous definition of civil engineering, which appears in the charter of the Institution of Civil Engineers (London), dating from 1828, commences with the excellent phrase "—the art of directing the great sources of power in nature for the use and convenience of man—." In Tredgold's time there were only two recognised types of engineering—*i.e.* civil and military. At the present time, nearly forty different branches of engineering have been itemised in technical literature. For the purposes of this discussion the following broad definition is suggested to cover all types of non-military engineering: "the economic application of the sciences to construction, production or useful accomplishment, especially on a large scale."

From this point of view, engineering manifests itself as the activating principle in the industrial world. Engineering, in this sense, must not only be coeval in antiquity with civilisation; but the degree of engineering attainment in any age must also necessarily be an index or criterion of its civilisation, judged from the material aspect.

The present era, which is essentially an engineering age, may be said to date from the introduction of the steam engine, and in that sense is only about one hundred years old. The application of the science of heat, in relation to steam for generating power, rapidly changed the nature of production from the individual-worker system to the factory system, augmenting greatly the output of a day's work. This in turn brought new dense factory populations, and also brought the means of supporting them. The so-called industrial revolution, thus started, brought tremendous sociological changes in its wake. Rapid steam transportation accelerated commerce and developed markets. It enabled producers to find sales for their products over a continually enlarged area. A sense of economic emancipation dawned over mankind.

During the Middle Ages and the Renaissance the study of science was slowly advancing in the western world, mainly under the guidance of the universities. This study consecutively followed the growth of mathematics, and was seldom directed to engineering applications. The natural philosophers, chemists and mathematicians who lived in the early years of the nineteenth century, taught and worked in intellectual regions usually remote from applications to utility. The rapid growth of the steam engine for driving factory machines, in the early years of the engineering era, brought into existence the mechanical engineer, who received his training in the workshop and factory. The mechanical engineer was compelled to study the nature of heat engines and of combustion, the laws of mechanics, and the properties of machines. This scientific study was, at first, more or less empirical and unsystematic. In the early days of mechanical engineering the physicists and scientists were ordinarily so far removed in their experiences from machines and engineering that they saw no way of co-operating with the engineer; while the engineer was so completely engrossed with the practical details of his work that he could see no way of receiving help from theoretical science.

The last few decades have steadily drawn together these two types of men and schools of thought, by mutual modification. The constantly increasing scale of machinery and machine production has necessitated more concentrated scientific study of the principles involved. The engineering applications have demanded more scientific knowledge, and the scientists have become more interested in applications. Until about fifty years ago the initial training of a young engineer, after leaving school, was either by apprenticeship to an engineering workshop, or by being articled, as an assistant, to a practising engineer. It is now recognised that the best training is in an engineering school of a university or technical college, where special study is devoted to the fundamental arts and sciences, followed by technical or applied science in some particular branch.

It is not only in the particular fields of engineering that this close dependence of application upon the sciences has become essential; but also in manufacturing and general production. It may be safely asserted that manufacture, on a large scale, is so closely associated with engineering processes as virtually to become engineering itself. In other words, in order to carry on manufacture economically, on a large scale, the process is practically the same as engineering. There is the same need for scientific study of the principles and basic materials involved, the same need for careful and thorough design, with the view of eliminating waste in material, plant or labour, the same need for experience and skill in the various stages of the work, and the same necessity for careful preliminary estimates of cost, as well as of checking the cost in successive stages.

Every labour-saving appliance in manufacture, and every scientific improvement introduced into its procedure, is a new evidence of the identity between modern manufacture and engineering. A manufacturing community, in modern times of competition and development, is of necessity an engineering community.

Prior to the amalgamation of science and industry in our present engineering age, the advancement of science was made mainly in places where science was studied and taught; *i.e.* in universities, or institutions of scientific learning associated therewith. Since the amalgamation, however, an increasing share in the advancement of science has been carried on in engineering establishments; *i.e.* in industrial laboratories, in factory laboratories, or in government and state laboratories. In future, the advances of engineering, and of the sciences upon which engineering depends, will be so bound up and interconnected that whatever gives one a step forward must also give a like impulse to the other.

It would no longer be possible to maintain the huge

[1] From the address of the retiring chairman delivered on December 30, 1925, before Section M (Engineering), at the Kansas City meeting of the American Association for the Advancement of Science.

populations of many large cities in the world without engineering; *i.e.* without the continued economic application of the sciences to the supply of the many products those cities require.

Although the needs of utility have in recent years either suggested or demanded numerous scientific researches, it is manifest that many other researches in the sciences are and will doubtless continue to be made exclusively for the truth's sake, and independently of any specific utilitarian need. It is only necessary to consider any scientific subject in all its bearings, to realise that this must be so. The great science of mathematics, for example, must evidently be greater than the sum of all its applications; so that unless all scientific curiosity as to the nature of new mathematical relations shall disappear, many investigations must continue to be made into branches of the subject that appear to have no immediate applications. Moreover, many cases of scientific research which have been made without any suspicion of applicability have afterwards come to be applied to very practical use. It would seem that the only differences which necessarily separate a scientific research of the basic or non-applied type, from one of the applied type, lie in the aims and motives of the researcher. In other words, one and the same research, conducted in the same way, may be an applied-science research or a basic-science research, according only to the purpose in the mind of the person who carries on the work.

It is generally conceded that researches carried on for the advancement of science tend strongly to stimulate the imagination. The investigator is called upon, at every stage of experimental inquiry, to speculate upon all the possibilities that present themselves, and to set up a new test that may serve to demonstrate which are the actualities and which the unrealities. It is not so generally recognised, however, that the work of the designing engineer also makes special claim upon his imaginative powers in the material realm. Any new project, such as a large bridge, building, railroad or power plant, calls for a careful estimate and design. It has to be completely visualised, part by part, in the mind of the designer, before construction commences. The designer has then, either alone or with the aid of assistants, to realise his plans in two-dimensional drawings. A large project may involve the preparation of many hundreds of drawings, in advance of assembling the materials. All of these drawings must interlock and connect in technique and dimensions. Tracings and blueprints from these drawings are then provided for guiding the constructors in their various tasks. The assemblage of design drawings embodies in most new undertakings a considerable amount of invention, imagination and creative work, which the builders proceed to translate from small scales in two dimensions, to full-size three-dimensional reality. To the trained eye, a good construction blueprint reveals, under its network of lines, a wonderful image of reality.

In the engineering of building construction, provision is made for the proper conservation of æsthetic grace, by the profession of architecture. On its artistic side, architecture seeks to foster and promote the art of beautiful building construction. This professional attitude towards art in the engineering of buildings guides public opinion in such a way that graceless and inharmonious buildings seldom escape popular censure. In other branches of engineering the æsthetic quality of the product does not at present find similar professional safeguard. Nevertheless, there is, for each type of engineering construction, a certain somewhat indefinite standard of artistic appearance below which the designers and builders are sure to encounter hostile criticism. In every country, new types of machines, which are experimental and have not yet established their right to survive, are usually revealed by their awkward appearance. Each country develops, as a general rule, its own type of æsthetic standards in appearance, and experts frequently detect, in this way, the nationality of machines and the relative artistic engineering excellence of the nations in which those machines were produced. It is here again that the advancement of science reacts upon advancement in engineering; because the harmony in Nature that scientific study discloses, tends to guide the minds of those who apply the great principles of Nature to the satisfaction of human needs.

Just as the advancement of engineering construction, as for example in telescopes, is constantly tending to the advancement of the sciences, or of astronomy in the case considered; so in return the advancement of science is constantly tending to the advancement of engineering processes. Thus, the precision of geodetic surveying has greatly increased during the last few decades, owing to progress in the sciences of astronomy, mathematics, physics, metallurgy, geology, and others. Moreover, the demands made upon engineering design and construction tend ever to become more exacting. For example, it has recently been stated that the great new Philadelphia-Camden bridge across the river Delaware is the first in which the supporting towers have had to be given extra strength to withstand the possible accidental impact of an aeroplane.

So close is the present interconnexion between science and engineering that the only salient distinction between them lies in their respective relations to economics. Questions of cost inevitably present themselves in the study of basic scientific problems, if only as limitations to equipment; but they are ever present in the study of engineering problems. Indeed, engineering problems call for special methods of accounting, and emphasise the importance of determining amortisation, depreciation, effective rates of interest and present values of plants. The stock-takings of large-scale businesses likewise tend to become both economic and engineering inquiries.

As the entire civilised world becomes more and more given over to engineering, if only in order to support its large populations, it becomes evident that the conversion of factories for producing utilities into agencies for developing destructive and poverty-making warlike implements, is ever easier. The power of science to create in the hands of those who help, becomes equally the power to destroy in the hands of those who fight. The world has only too recently seen how terribly destructive the powers of science and engineering can become in war among the industrialised nations. Modern war is engineering gone mad. This misuse is, of course, no fault of either science or engineering. If, however, in the reasonably probable advance of both, we are to avoid the utter destruction of civilisation by war, and the economic servitude of posterity in its wake, we must all unite in building an international organisation that shall not only tend to prevent the onset of war but shall also swiftly suppress its first outbreaks. In any such organisation, both science and engineering are sure to be powerful elements for effecting control. Under such control, once successfully established, the advancement of science and engineering should surely promote and maintain world peace. Even now all science and its applications are essentially international. No way has ever been found to make science operate exclusively for the benefit of one nation, or portion of the globe.

In the basic sciences, the units of measure employed are almost universally the simple units of the international metric system—the metre and the gram—with their derivatives. In engineering and applied science, the units employed have gradually likewise become metric in all parts of the world except in the English-speaking countries, where both the time-honoured but cumbersome English and American systems of units persist. Even in the English-speaking countries, however, a gradual transition may be perceived towards the ultimately inevitable international metric system. When the transition shall have become complete, the mutual advances in engineering and in science will be rendered more easy and rapid, through the use of the same language of units. This simplification will benefit science and engineering in all parts of the world.

The advances of science and of engineering have thus far always enriched mankind materially. Material production has been greatly hastened; so that the average possessions of men have been increased, or else larger populations have been supported to divide the increase. It is doubtful, however, whether increase of human happiness, beyond a relatively small modicum of possessions, is at all commensurate either with the growth of material wealth or with the growth of population. It seems that while science can largely increase general comfort and prosperity, it can, at present, ensure but little increase of happiness and contentment. Whether this must always and inevitably be so, is debatable, and depends to some extent on our definitions of science. In any case we must turn for help to moral and spiritual sources of happiness if we are to continue to become increasingly indebted for material wealth to the scientific revelations of the interpretable universe. At present it appears that advancement in the power to enjoy and give contentment is more difficult for us collectively to acquire than advancement in the power to secure material benefit through science and engineering. In the discovery and maintenance of these uplifting philosophies the calm and contemplative Orient has surpassed the tense and restless Occident.

It is generally admitted that the study, either of the sciences or their applications, tends to produce in the mind of the student a sense of humility and a respect for truth. Indeed, it is not strange that habits of seeking or applying scientific truths should engender habits of faithful thinking. In this respect there is encouragement in the belief that the tendency of the present engineering age is, on the whole, towards accuracy of reasoning and precision of thought. Scientific ideas may tend slowly to dominate over irrational and irregular thinking. A casual review of general literature over long periods of time seems to show that as science has advanced, irrational and superstitious ideas have dwindled. The concomitant danger, however, lies in the occasional ravages of erroneous pseudo-scientific doctrines. A plausible but false doctrine, that masquerades as a scientific proposition, may produce more harm in a scientifically disposed world than a flagrantly immoral popular belief of a clearly irrational character. The responsibility for making unguarded statements that are unsupported scientifically, thus rests increasingly upon all speakers and writers.

In the development of the applied sciences, a constantly increasing demand devolves upon the underlying basic sciences. In the prehistoric times of primitive engineering, only the simple rudiments of the underlying sciences may have been involved. In the ancient Egyptian and Roman days, engineering must have demanded a closer study of mathematics and physics for support. Since, however, the dawn of the present engineering age, much more knowledge and research have been demanded in a long list of the branches of basic science. Invention is always needed. But whereas in past times, inventors, if they had the requisite talents, did not need much scientific knowledge, at the present time the successful inventor has not only to be endowed with inventive ability, but he must also be well versed in basic science. It appears that in the future this demand for basic scientific knowledge, as a prerequisite to applied-science progress, will continually increase.

The leadership of the ancient world rested mainly upon physical force. The trend of the more recent past, through the present, towards the future, is for world leadership among the nations to rest mainly upon science and its applications. Already the progress of engineering is hampered and thwarted in many directions by lack of advance in the basic sciences. It is to these that national attention should be directed for the progress of the knowledge that benefits first the nation in which it is made, and later all the other nations. If only in the interests of applied science, the advancement of basic science should be stimulated and fostered. Support for applied science is likely to be forthcoming from the industries themselves; but support for basic science is more difficult to secure.

The national importance of this is so great that the need should be made widely known. An effective way to stimulate advance in the sciences in the United States would be to secure permanent endowment for a suitable annual prize, to the most notable contribution each year, in each section of the American Association for the Advancement of Science. This official recognition of scientific achievement would stimulate and encourage researchers in all the sections. There is no reason to fear that such scientific progress might be practically valueless. Useless scientific knowledge is now a contradiction in terms. Moreover, aside from the question of immediate versus future application, the patient earnest study of truth, in those parts of the universe that are attainable to us mortals, constitutes the noblest quest with which we are yet acquainted.

The Production of Motor Spirit from Heavy Oils.

By Dr. A. E. DUNSTAN.

IT is obvious that the provision of adequate supplies of motor fuel is a fundamental necessity of modern civilisation. Thirty years ago the light fractions of petroleum were not only a by-product in the preparation of kerosene, but also a positive nuisance, and vast quantities were deliberately burnt. In the interim the demand for motor spirit has steadily increased, and to-day has reached the colossal figure of eleven thousand million gallons per annum, Great Britain consuming nearly four hundred and fifty million gallons in the year.

This demand is increasing at the rate of about 30 per cent. a year in Britain alone, whilst the rate of increase on the Continent when trade becomes prosperous will inevitably be steeper than that in England. Last year, of the total amount of petrol produced in the United States, the straight-run gasoline distilled from the crude amounted to 56 per cent., cracked gasoline 33 per cent., natural gas or casing-head gasoline 10 per cent., and benzene 1 per cent.

It is clear that "cracking," *i.e.* the conversion of heavy oil into lighter products, is playing a more and more important part in the provision of motor spirit. The first successful attempts to bring about the conversion of heavy oils into lighter products were achieved by Dewar and Redwood in 1889 (English Patent 10277), and the object of this operation was the conversion of gas oil into burning oil. It was many years later that the conversion of burning oil and gas oil into petrol became desirable and practicable.

Although Redwood's patent was taken out in 1889, the writer had the advantage of seeing some time ago in Edinburgh a lay-out of a shale oil refinery in which this operation was actually provided for so far back as 1865.

The actual origin of cracking in the United States is supposed to be due to the carelessness of a stillman who, having left a still running, returned some hours later and found that a lighter distillate was being produced, and this was traced to condensate dripping from the upper cooler part of the still on to the hot residue. Between this early discovery and present-day big-scale cracking lies a period of intensive development, and it was only the perseverance of Dr. Burton that led to a refinery procedure being established on a large scale. The Burton process is really indistinguishable from that put forward by Dewar and Redwood; in effect, Burton merely heated petroleum residues at a temperature of 700° F. under a pressure of 4-5 atmospheres, the pressure being maintained right up to the outlet of the condenser. The real difference lies in the fact that Burton had developed the same procedure, but to a different end—the production of gasoline.

The first Burton patent was taken out in 1912. For a long time the Burton process was regarded with some disfavour, because of the relatively high pressure maintained in the still and the somewhat serious risks incurred by heating large masses of oil under these conditions, and the attention of innumerable investigators was directed to the cracking of hydrocarbons under atmospheric pressure. In Great Britain, for example, about the years 1913 to 1916, two at least of such processes were in operation. They failed, however, because the serious drawback of low pressure operation is a high yield of gas with corresponding low yield of gasoline, and that of a nature which makes refining extremely difficult. As will be seen in the sequel, it is by no means certain that vapour-phase cracking at atmospheric temperature is entirely defunct, because the nature of the spirit produced does offer certain advantages as a fuel for modern high-compression engines.

During the War, quite a considerable amount of attention was paid to vapour-phase cracking from an entirely different point of view. It has long been known that at temperatures in the neighbourhood of 750° C., paraffinoid hydrocarbons may be cracked, yielding considerable percentages of aromatic hydrocarbons. In a large-scale experimental plant operated at Thameshaven in 1916, working with heavy Persian oil distillates, a spirit was produced which contained no less than 16 per cent. of toluene.

Between 1916 and the last few years, however, the attention of inventors has been almost entirely directed to cracking under pressure, because it has been found that the spirit produced in this way is not only higher in yield but is also accompanied by far less gas and coke.

One or two typical methods of procedure may be very briefly outlined. In essence, all these processes consist of two parts: A pipe-still through which the oil is passed with considerable velocity at high temperature and pressure into a reaction vessel, in which it is maintained under pressure for varying lengths of time.

In the Cross apparatus—which is one of the most popular types—the oil is raised in the pipe-still to a temperature of about 470° C. and then passes into a reactor, which consists of a horizontal steel cylinder 40 ft. long, 38 in. in diameter, with walls 3 in. thick. The reactor is not directly heated, but is heavily lagged, and the oil is held in this chamber long enough to establish equilibrium between the liquid and vapour phases. This period is about 15-20 minutes, and the oil falls in temperature 50° between the inlet and the outlet. The operating pressure may amount to 750 lb. to the square inch. Normally in this process the amount of coke produced is less than 1 per cent.

After the reaction is complete, the oil is discharged into a separator and thence the vapours pass to the dephlegmator, where the temperature is regulated to yield gasoline to the required specification. The gas that is produced is nearly sufficient to maintain the necessary temperature in the plant. A modern unit will process 2000 barrels of oil per day, and if the intermediate oils produced in the operation be recycled to the plant, it is claimed that the yield of gasoline from a gas oil fraction may reach 65 per cent.

The Carleton-Ellis developments have led to the adoption of a vertical reactor which may be in duplicate. Oil is fed through the pipe-still under a pressure of 350 lb. and passes into vertical steel vessels, in which again the time factor is allowed to have its effect. After the reactor comes the dephlegmator.

The Dubbs' system is particularly adapted to the cracking of residue oils, although of course it will function on distillates. The process is simple in that the oil, after leaving the pipe-still, passes into a large reactor under a much lower pressure than that used by the Cross system. In the standard plant the oil enters the reaction chamber at 450° C., and the vessel is 10 ft. in diameter and may reach 30 ft. in height, with a capacity for coke ranging from 30 tons upwards. From the reactor again the vapours are subjected to dephlegmation, and a heavy condensate can be passed along with the incoming crude oil to the pipe-still.

The question of temperature in liquid-phase cracking is decided by the particular oil under treatment and the amount of gasoline required, because there appears to be a definite relationship between the variables time, temperature, and yield. It is interesting to note that the percentage of spirit obtained, after the oil has reached a definite cracking temperature, appears to double, within limits, for an increase of 10° C.

There has been little advance in our knowledge of cracking from a chemical point of view during the past ten years, because problems connected with cracking processes have been more often of an engineering nature, and the most urgent question to the majority of operators is the possibility of elimination—or at any rate the diminution—of coke, so that the plant may run continuously without the necessity for frequent shut-downs for cleaning.

It is surprising how little progress has been made in the examination of the residues left after the cracked gasoline has been removed from the synthetic crude oil, and investigators would do well to bear in mind that herein lies reactive material of unknown constitution, knowledge of which would probably amply repay intensive research.

Recent development in the design of the high speed, high compression, and high efficiency light car engine has brought to notice the importance of suitable fuel. It is in this connexion that cracked spirit shows particular advantages over straight run gasoline, in that it withstands high compression and is less prone to detonation, and it is a fact that, at the moment, quite considerable quantities of this material are being marketed as "anti-knock" motor spirit. The vapour phase product, having been processed at considerably higher temperatures, is specially noteworthy from this point of view.

No account of the present position of oil-cracking to-day would be complete without some consideration of the Bergius process, about which such far-reaching claims have been made. From the early work of Bergius there emerged the formation of artificial coal from cellulose at temperatures of 350° C. and pressures of more than 100 atmospheres. This substance was capable of hydrogenation by being heated to 400° C. in the presence of hydrogen at very high pressures. From this observation naturally led the application of hydrogenation to coal itself.

An entirely new technique had to be developed in this research and its later development, and only the discovery of a new method of joint construction rendered possible the application of very high pressures to this problem.

A commercial plant has been set up at Rheinau, and consists of an autoclave 30 ft. long × 3 ft. in diameter, fitted with stirring device and capable of handling 50 tons of material a day, under a pressure which may reach nearly 300 atmospheres.

In the case of coal, the material is ground to pass a 400-mesh sieve and is mixed with oil to permit of its passage through pipes. The autoclave is heated very ingeniously by surrounding it with heated nitrogen under pressure. Bergius has claimed that any coal containing less than 84 per cent. of carbon on an ash-free basis can be successfully hydrogenated.

In this connexion a good deal of work has been carried out the last few years in Great Britain, more particularly in the University of Birmingham, which more or less substantiates claims advanced by Bergius, and a variety of coals, lignites, and so on have been liquefied; but it should be borne in mind that the liquid product, whatever it may be, is certainly not petroleum, seeing that it contains liquid compounds of oxygen, sulphur, and nitrogen; and at the moment of writing it can be safely stated that the process has not yet been placed on a commercial basis.

Obituary.

PROF. EDMUND KNECHT.

BY the death of Prof. Edmund Knecht, associate-professor of technological chemistry in the College of Technology, University of Manchester, chemistry, as applied to dyeing and other branches of textile industry, has lost one of its chief exponents.

Henry Edmund Knecht was the third son of Gustave Knecht, B.Sc. (Lond.), a Swiss who became a naturalised Englishman and for many years had a large private school in Liverpool, where Dr. Knecht was born in 1861. His mother was English. On leaving school he matriculated at the University of Zürich, studying chemistry under Victor Mayer, to whom later he acted as assistant. He graduated Ph.D. at the Swiss Federal Polytechnic in 1882, and returned to England in 1883 on his appointment as Head of the Department of Chemistry and Dyeing of the then newly opened Bradford Technical College. In 1890 he entered upon the long period of service at the Manchester College of Technology which ended only with his death.

When the Society of Dyers and Colourists was formed in 1884, Dr. Knecht became the first editor of the journal of the Society, a position which he held continuously for forty-one years and was the source of great satisfaction to him. To commemorate the completion of the fortieth year of his editorship, an excellent portrait of Dr. Knecht was issued with the journal and a valuable presentation was made to him, towards which subscriptions were received from the United States, Canada, India, Japan, and most European countries—for he had friends and admirers the world over.

Dr. Knecht was an indefatigable and prolific worker, his published researches, which number more than one hundred, appearing in the *Journal of the Society of Dyers and Colourists*, the *Journal of the Chemical Society*, the *Berichte*, and elsewhere. They cover a wide range, dealing with the production and application of dyestuffs, the chemistry of textile fibres and textile processes, etc. He also developed an entirely new series of analytical processes based on the use of titanium salts. He was the author alone or in collaboration of several standard works on dyeing, printing, and allied industries, the best known being the "Manual of Dyeing" by Knecht, Rawson, and Loewenthal. He also contributed a number of articles to the last edition of the "Encyclopædia Britannica."

Dr. Knecht was in good health until July last, when he underwent a serious operation from which he made a good recovery. Going to Switzerland to recuperate, he remained there until November, but during the whole time kept in close touch with the investigations carried on by his assistants in Manchester. Arriving in England during one of the worst fogs experienced for years, he caught a chill which developed into bronchitis, and he succumbed quite suddenly to heart failure on December 8 last, at his home at Marple, Cheshire.

As a teacher Prof. Knecht acquired a great reputation, not mainly through formal lecturing but by personal contact and example in the laboratory. The letters received from past students in many parts of the world at the time of the presentation recently made to him indicate the abiding affection in which many of them held "the Doctor."

Dr. Knecht was never married, but is survived by three sisters. He had the gifts of humour and good comradeship, but to hide an excessive sensitiveness and shyness he had also a natural reticence which was penetrated only by his intimate friends. His publications are characterised by sound judgment and lucidity, and frequently by those flashes of vision which connote genius. To no other man does the Society of Dyers and Colourists so largely owe its present considerable reputation; and it may truly be said that no man in any country has done more to enrich our scientific knowledge of textile materials and processes.

WALTER M. GARDNER.

MR. R. B. NEWTON, I.S.O.

RICHARD BULLEN NEWTON, lately senior assistant in the Geological Department of the British Museum, was born in London on February 23, 1854. His father was Librarian and his uncle (Mr. E. T. Newton, F.R.S.) Palæontologist to the Geological Survey. He was educated at the Central London Foundation School, Cowper Street, entering there as one of the first scholars. At the age of thirteen years, Newton obtained work at the Geological Survey, and in 1873 became one of the assistant naturalists under Huxley. In 1880 he was transferred to the British Museum and was soon engaged in the removal of the geological collections from Bloomsbury, and the rearrangement in their new home at South Kensington. He became an expert conchologist and especially interested himself in the Tertiary Mollusca, issuing a systematic list of the Edwards Collection in 1891. Other contributions flowed from his pen, to the number of about a hundred; many of them, though professedly systematic reports on collections of fossils sent to the Museum from distant regions, constituted considerable additions to our geological knowledge of Africa, Asia, and the near East. Another branch of his work was the study of the Foraminifera as guides to geological horizons.

In 1914 Mr. Newton received the Wollaston Fund from the Geological Society of London. He was president of the Malacological (1910–12) and of the Conchological Society (1913–15). His wide knowledge of fossils and their literature and his familiarity with the national collection made his services of much value to the British Museum and to the Empire at large. Since his retirement from the service he had continued to work in his old room at the Museum, and was hard at work there until, only a few days since, he left to undergo the operation to the effects of which he succumbed on January 23, in his seventy-second year. His helpful presence will be greatly missed by all his colleagues.

F. A. B.

WE regret to announce the death of Dr. Karl Goldschmidt, chairman of the directors and for many years head of the executive of the firm of Th. Goldschmidt and Co., of Essen, who succumbed to an operation on January 5 at Stuttgart, at the age of sixty-eight. He and his brother, the late Prof. Hans Goldschmidt, were well known as the inventors of "thermit," and in a recent monograph entitled "Aluminothermie," Karl Goldschmidt has described fully the nature and importance of the thermit-reaction. The brothers inherited from their father a chemical manufacturing business, which they transferred from Berlin to Essen thirty-five years ago. Under the management of Karl Goldschmidt, the business developed enormously and in 1911 it became a public company.

WE regret to announce the following deaths:

Dr. Charles A. Doremus, formerly professor of chemistry and toxicology at the University of Buffalo, known for his work on foods and on the chemistry of sanitation, on December 2, aged seventy-four years.

Mr. C. M. Doughty, honorary fellow of Gonville and Caius College, Cambridge, traveller and poet, the author of "Travels in Arabia Deserta," on January 21, aged eighty-two years.

Dr. C. Iris Fox, senior assistant pathologist at the Royal Free Hospital, Gray's Inn Road, London, who died as the result of a poisoned finger sustained during a *post-mortem* examination, on January 21.

Prof. C. Golgi, emeritus professor in the University of Pavia, Nobel prizeman in medicine with Prof. Ramon y Cajal in 1906, and distinguished for his work on the histology of the nervous system, on January 21.

Prof. H. A. Gossard, chief of the Department of Entomology of the Ohio Agricultural Experiment Station and president of the American Association of Economic Entomologists, on December 18, aged fifty-seven years.

Dr. W. R. Lang, formerly professor of chemistry in the University of Toronto, known for his work on low-temperature phenomena and on the chemical industries of Canada, on November 20.

Prof. Edward S. Morse, formerly professor of comparative anatomy at Bowdoin College, and also of zoology at Tokyo, an authority on Mollusca and on Japanese ceramics, who was president in 1886 of the American Association for the Advancement of Science, aged eighty-seven years.

News and Views.

An interesting announcement was made by Lord Reading in his speech as Viceroy at the opening of the Indian Legislature on January 20. A Royal Commission is about to be appointed: "generally to examine and report on the present conditions of agricultural and rural economy in British India." There follow particular directions, of which one is glad to see that the first subject of investigation will be "the measures now being taken for the promotion of agricultural and veterinary research." From time to time we have had occasion to direct attention to the remarkable success—particularly in plant-breeding—that has followed the labours of research workers at Pusa and other centres in India. There can be little doubt that the economic results that have already been achieved will impress the Commission, and that, as a result, a further extension of the work will be recommended. We hope the Commission will pursue the matter to the conclusion which the experience of state-directed research in Great Britain suggests, namely, that the successful exploitation of scientific research rests, in the last analysis, on fostering the supply of scientific workers. Considering the subject of economic botany alone, it is a somewhat remarkable fact that—save in some degree in the University of London—no universities in Great Britain undertake the specialised training of botanists in the economic aspects of the science. For some years past there has been a strong demand from India and the Dominions for trained geneticists, mycologists, and entomologists. It is not suggested that it would be possible to train men in England in the specific applications of these subjects in foreign countries, but training in the principles of the economic application of such sciences as genetics might well be attempted. As a corollary to this proposition, the new Commission might perhaps consider the desirability of assisting the universities by means of scholarship grants, or otherwise, following the time-honoured precedent of recruitment for the Indian Civil Service.

Presumably the Secretary of State for the Colonies will soon proceed to the appointment of a Director of the Amani Institute in Tanganyika. On December 9 the announcement was made in the Kenya Legislative Council that following on the recommendation of the East Africa Parliamentary Commission, the Secretary of State for the Colonies was taking steps for the re-establishment of this Institute. Each of the East African territories was asked to make a contribution towards its maintenance, their total contributions amounting to 8000*l*. yearly. In addition, initial capital expenditure of 6000*l*. was to be incurred. The contribution of the Imperial Government had not then been determined but it was hoped a sum would be set aside from the 10,000,000*l*. development loan. This announcement was received with enthusiasm by the representative of the Kenya settlers, Lord Delamere, who stated that the Colony stood to gain advantages out of all proportion to the contribution of 1200*l*. for which it was asked to make provision. But as the *East African Standard* pertinently remarks, the selection of the staff will need to be made carefully. It is obvious that the Director should be an able administrator and one who can command the confidence and continued support of the Governors, the Directors of Agriculture, the settlers, and the leading traders—preferably one who has a knowledge of the varied elements of the population and its needs. For upon his relations with the various administrative and executive elements in the territories and his knowledge of the conditions prevailing will the success of this experiment depend. Perhaps these qualities can be found in one who could bring also a specialist's experience to bear upon the scientific problems with which the Institute is to deal. But the other desiderata should be the determining factors in the choice of a Director who will secure for the Institute the confidence and support necessary for its success.

The two children's lectures under the Dr. Mann Trust at the Royal Society of Arts this year assumed a strikingly novel form in the hands of Prof. H. E. Armstrong. They were, in fact, not lectures at all in the conventional sense. Prof. Armstrong conceived the characteristically original plan of imparting a notion of scientific method and its application to some simple things of daily life by going back to Lewis Carroll and the immortal Alice, and the lectures were entitled "Alice in Wonderland at the Breakfast Table." The plan was that a team of children assuming the familiar characters and acting under the general direction and commentary of Prof. Armstrong as a sort of Sage, should work out an experimental elucidation of some questions centring round carbon. Beginning with sugar and an excursion into the realm of nutrition, the course ended with the chemistry of egg-shell substance. The experimental procedure was masked, so far as possible, by breakfast-table appliances and procedure on "Alice" lines, and excellent effects were obtained by the use of very simple properties.

It was evident that much thought and ingenuity had been bestowed by Prof. Armstrong upon the production, but there had been a singular spell of ill-luck, several important members of the caste having to fall out at a late stage owing to illness or quarantine. In these circumstances the presentation necessarily seemed somewhat unrehearsed. The experimental part was excellently conceived and executed. The Mad Hatter had fortunately maintained a clean bill of health and played his leading part quite admirably. He had upon him (perhaps unconsciously) the burden of being the grandson of the two men who, in their generation, did more than any of their contemporaries to make science-teachers consider their ways—Prof. Armstrong in the physical and the late Prof. Miall in the natural history sciences. Though the representation suffered from the troubles already referred to, and though the "book" and comments in some places seemed to be a little out of tune with the juvenile mind, the venture was of very remarkable originality and interest. It left some of the adult members of the audience with the feeling that if Prof. Armstrong were to take his troupe on a provincial tour, it might reappear in one of the little (chemical) theatres of London and even make a modest bid for favour at Christmas with "Peter Pan."

IN his Friday evening discourse at the Royal Institution on January 22, Sir William Bragg dealt with "The Work of the Davy Faraday Research Laboratory." He said the Laboratory was founded in 1896 by the late Dr. Ludwig Mond, who provided building, equipment, furniture and an endowment for its upkeep. It was entrusted to the care of the managers of the Royal Institution. Its purpose was the development and extension of chemical and physical research by methods suggested in the deed of trust, or by any other means that appealed to those in charge of the Laboratory. It was to be open to workers of any nationality, the sole qualification being the ability to carry on research, and no fees or expenses for electricity, water or gas were to be charged. This was, indeed, a free and generous foundation. The laboratory is well adapted to team work, inasmuch as it provides room for some fifteen to twenty workers, who can conveniently exchange ideas and give mutual assistance. It is actually employed in this manner, and all its rooms are occupied. The main problem under attack is the application of the new X-ray methods to the study of organic substances, that is to say, such substances as are of main importance in living organisms, and such other substances as are of similar structure and composition. This covers a vast range of materials, fats, oils, paraffins, alcohols, dyes, explosives, and so on. The work done is in the main contained in the realm of pure science. The new methods of analysis by X-rays are continually showing promise of useful applications to many industrial problems, but it is desirable that such laboratories as the Davy Faraday and the university laboratories should not allow themselves to be drawn away too far from the problems of pure research. If the latter be neglected, industrial applications will in the end lose their vitality.

IN the improvement of our roads and canals in pre-railway times none played a more important part than Thomas Telford, whose great bridge over the Menai Straits was one of the finest engineering feats of the time. The bridge was opened on January 30, 1826, by the passage of the London and Holyhead mail coach across it, and it has therefore been in use for just a century. Its central span is 580 feet, while the carriage way is carried at a height of 100 feet above the water way. Early iron suspension bridges were usually made of ordinary chains, but in the Menai Bridge, Telford formed his links of flat bar iron 1 inch thick, $3\frac{1}{4}$ inches wide, and 10 feet long. There are sixteen chains in all and the total sectional area of the main chains is 260 square inches. The cost of the bridge was 120,000*l*. Telford was sixty-eight years of age when the bridge was opened, but he continued to practise his profession until almost the end of his life. He died at 4 Abington Street, Westminster, on September 2, 1834, and was buried in Westminster Abbey.

THE official opening on Thursday last, January 21, by Lord Lloyd, of the Sennar Dam across the Blue Nile at Makwar in the Sudan, marks the completion of the first stage of a great enterprise by which, ultimately, something like 3,000,000 feddans (Egyptian acres) of hitherto barren land will be rendered cultivable. The full scheme contemplates the provision of two dams, the second being across the White Nile at Gebel Aulia, a short distance south of Khartum; this will be required to ensure the summer water needs of Egypt. The area immediately available for cultivation amounts to 300,000 feddans and lies in the valley of the Blue Nile below Wad el Haddad, to the west of Barakat, which is the headquarters of the Sudan Plantations Syndicate, where a cotton-ginning factory has been established. The Sennar Dam is 3025 metres in length, but only 1800 metres of this is dam, properly so called, the remainder being side walling on the banks. The height of the crest of the dam above the river bed is 26 metres, and the foundations go down some 10 to 12 metres. There are 80 sluices in the main structure, each 8·4 metres by 2 metres; and 14 sluices (each 5 metres by 3 metres) for the regulation of the irrigation canal. The quantity of masonry in the dam is 423,000 cu. metres. The reservoir has a capacity of 636 million cu. metres, or about one-quarter the capacity of the enlarged Aswan reservoir.

THE Netherlands expedition to the Karakoram Range under the leadership of Mr. P. C. Visser made several important discoveries during the past year. From a preliminary account in the *Times* of January 18, it appears that from Hunza the expedition ascended the Hunza valley and then branched off into the Bara-Khun valley, which was found to drain a vast region of glaciers and peaks of more than 22,000 feet. Then the Khunjerab valley was ascended and a high but comparatively easy pass was discovered leading to the Ghujerab valley. From this valley, which proves to be occupied by the longest of the head streams of the Hunza, by a lofty pass the Shimshal valley was reached. At the head of this valley two great glaciers were discovered, the Khordopin, 32 miles long, and the Verijerab, almost as long. A third glacier, the Yazghil, which flows in from the south, was explored. Mr. Visser believes this heavily glaciated region to include the largest expanses of ice in the world outside polar regions. Other explorations included an ascent of the Batura glacier, which was found to be 37 miles long, and a northern branch of the Hispar glacier flowing from the southern side of the high peak of Malunguti. The expedition, in addition to mapping more than 2000 square miles, has made large scientific collections. A full account of the work is to be given shortly to the Royal Geographical Society.

AN exhibit of models illustrative of flint flaking made by Mr. S. Hazzledine Warren will be held in the lecture room of the Royal Anthropological Institute at 52 Upper Bedford Place throughout the month of February, during the hours at which the Institute is open. Fellows and others who may be interested in the subject are cordially invited to visit this exhibition and examine the models. They number more than sixty, and are planned on similar lines to the models used in the study of comparative anatomy and other subjects. That is to say, they are painted in conventional colours to indicate the comparisons of homologous parts as developed under various human, mechanical, and natural processes of flaking. It is intended to make a limited number of duplicate sets of these models, as a first attempt towards a standard set for comparison. So far as good natural flakings are concerned, so few have yet been collected that, for the time being, museums generally do not, and cannot, possess adequate specimens. Although plaster casts are inferior to originals, it is hoped that they may prove better than none.

SIR GILBERT WALKER, the new president of the Royal Meteorological Society, succeeded Sir John Eliot as Director-General of Observatories, India, in 1904, and retired from that position after twenty years' service under the age rule. During his tenure of office as Director-General he attacked the complex problem that had puzzled all his predecessors, that of forecasting the monsoon rainfall, by the statistical method of using coefficients of correlation. His most noteworthy official contribution to meteorology is a memoir on "A Preliminary Study of World-Weather," in which he has collected together all the correlation coefficients, large or small, and has discussed the physical interpretation of his results. Sir Gilbert Walker was a senior wrangler and a fellow of Trinity College, Cambridge. He is now professor of meteorology at the Imperial College of Science and Technology, South Kensington, and has the distinction of being the only professor of meteorology in the British Isles.

LIEUT.-COL. E. GOLD, who was presented with the Symons Gold Medal of the Royal Meteorological Society at its annual meeting on January 20, is assistant director of the Meteorological Office, member of the Aeronautical Research Committee, and president of the Weather Telegraphy Commission of the International Meteorological Committee, 1919. He has carried out studies on the dynamics of the upper atmosphere, the thermal conditions of the stratosphere, etc., his researches in these subjects gaining him his fellowship of the Royal Society, and the prize, offered for competition to the whole world by the German Meteorological Society, for a discussion of the dynamics and meteorological statistics of the upper atmosphere. During the War he acted as organiser and chief of the British Meteorological Section of the Army in France, and was well known through the British Army areas as Meteor G.H.Q. This section was of enormous importance to the success of the Air Force and, more especially, the artillery.

SIR ERNEST RUTHERFORD received his education at the Nelson Boys' College and the Canterbury College, Christchurch, New Zealand, and on the occasion of his recent visit to Christchurch, he was presented with an illuminated address. It shows Sir Ernest Rutherford's school and college as they were when he attended them, the chemical laboratory in which he worked, and the house in which he was born. The wording of the address evidences the weight attached in Christchurch to scientific distinction, and the esteem in which Sir Ernest Rutherford is held in his native land. The decorations on the address are highly creditable to the artistic taste of the designer.

RAINFALL statistics over the British Isles for 1925 are given by the Meteorological Office, Air Ministry, in the monthly numbers of the *Meteorological Magazine*. The normal rainfall for the British Isles as a whole for the 35 years 1881 to 1915 is 41·41 inches, and the rainfall in 1925 for the several divisions of the British Isles is given as percentages of the normal. For the British Isles as a whole and in the divisions England and Wales, Scotland, and Ireland the rainfall was less than in 1924 and 1923. The mean for Great Britain and Ireland was 104 per cent. of the normal, the heaviest fall being 108 per cent. in England and Wales. February had the greatest excess of rain over the normal in England and Wales with 189 per cent. and June the lowest with 6 per cent. of the normal. In Scotland, May had the greatest excess with 191 per cent. of the normal and June the lowest with 39 per cent. of the normal; in Ireland, May had the greatest excess over the normal with 194 per cent. and June the least with 23 per cent.; for the British Isles as a whole, May had the greatest excess with 185 per cent. of the normal and June the least with 18 per cent. of the normal. At Camden Square, London, the principal station of the British Rainfall Organisation, the rainfall for the year was 24·91 in., which is 0·44 in. more than the normal. The wettest month was July with 3·58 in. of rain, which is 150 per cent. of the normal, but relatively February had more abnormal rain, the measurement being 2·86 in., which is 171 per cent. of the normal. The driest month was June with 0·11 in., which is only 5 per cent. of the normal.

A NOTE on "Drought, its Prevention and Cure" is given in the *Meteorological Magazine* for December from an article on the Kalahari project by Prof. E. H. L. Schwarz. The author is well known for his proposals to increase the rainfall of South Africa by reconstituting the ancient lakes of the Kalahari region. Instances are cited of the extensive desiccation of large areas originally extensive lakes, and this is especially treated with reference to Africa. The author mentions that in Central Africa the great lakes still function as sources of rain for the interior, but he refers to imminent danger that Lake Victoria will be drained into Tanganyika, with disaster to the whole Nile Valley. Attention is directed to the water supply to the Kalahari lakes being intercepted through the Victoria Falls probably about 500 years ago. River piracy and geographical changes are possible and even probable; the part which concerns meteorology is the effect of such changes on rainfall. Reasoning on certain internal changes in South Africa, the author points to an average decrease of about one inch per annum in the rainfall between the periods 1881 to 1900 and 1901 to 1920. The author of the note refers to Bathurst having a decrease of nine inches per annum during the same period, and at Sierra Leone a decrease of 25 inches per annum. Even in the Cape Verde islands in the open ocean, the rainfall has suffered a marked decrease. These facts are taken to suggest that the disappearance of the Kalahari lakes is part of some more general change which human endeavour cannot hope to cope with. The article was the subject recently of an interesting discussion in the Meteorological Office.

THE recently published list of sectional presidents at the British Association meeting in Oxford next August has been completed by the appointment of Sir John Snell, chairman of the Electricity Commission, as president of Section G (Engineering).

AT a meeting of the Zoological Society of London held on January 20, it was stated that the total number of visitors to the Society's Gardens for last year was 1,823,618, a decrease of 233,528 as compared with the previous year. The number of visitors to the Society's aquarium during the period was 423,657.

HIS Majesty the King has consented to become patron of the annual general meeting of the Society of Chemical Industry to be held in London during the week commencing on July 19. The third Messel Memorial Lecture will be delivered by Lord Balfour at the Mansion House on the afternoon of the first day of the meeting.

A LIMITED number of bacteriological microscopes by Koristka are being offered for sale at a reduced price by Messrs. The City Sale and Exchange, Ltd., 81 Aldersgate Street, London, E.C.1. The microscope stand has a wide body tube fitted with draw tube, and is provided with a double rack-and-pinion coarse adjustment, a graduated fine adjustment, rotating stage, and a sub-stage with focussing adjustment. We have examined one of these instruments and consider it well made and capable of giving useful service in serious bacteriological or general microscope work. It is equipped with three objectives, $\frac{2}{3}$ in., $\frac{1}{6}$ in., and $\frac{1}{12}$ in. oil immersion, in triple revolving nose-piece, three eye-pieces, and an Abbe condenser with iris diaphragm. The price for the complete equipment in carrying case is 19 guineas, and the firm is prepared to supply the instrument on seven days' approval and also, if desired, to accept payment by instalments.

WITH reference to the note in NATURE of January 23 (p. 136), on the discovery of the capelin in glacial nodules in S.E. Bosnia, Mr. Errol I. White, of the Department of Geology, British Museum (Natural History), informs us that one of the specimens has been presented to the national collection by Dr. St. John Bolkey and is on exhibition at the Museum.

DR. R. B. MOORE, formerly chief chemist of the U.S. Bureau of Mines, who was largely responsible for the development of helium production during the War, has been awarded the Perkin Medal for 1925 by the American section of the Society for Chemical Industry. The presentation was made on January 15.

THE Rivers Memorial Medal for anthropological work in the field for 1925 has been awarded by the Council of the Royal Anthropological Institute to Prof. C. G. Seligman for work in New Guinea, Ceylon, and the Sudan. The Medal was presented to Prof. Seligman by Dr. A. C. Haddon at the anniversary meeting of the Institute on January 26.

IT is stated in the *Times* that in celebration of the centenary of the death of Stanislas Staszic, scientific worker, business man, and statesman, the Polish Government has restored to the Warsaw Scientific Society the palace presented to that body by Staszic, but afterwards confiscated by the Russians.

THE treatment of tuberculosis with sanocrysin, a thiosulphate of sodium and gold, introduced by Prof. Mollgaard of Copenhagen, has attracted attention, and Prof. T. R. Elliott details the results he has obtained with it in eleven cases (*Lancet*, January 16, p. 126). He thinks that, used with care, the drug does no harm, and his impression is that it produces more rapid improvement in pulmonary tuberculosis than could be obtained by any other method of treatment.

THE Council of the Geological Society has this year made the following awards:—Wollaston Medal to Dr. Henry Fairfield Osborn of the American Museum of Natural History; Murchison Medal to Dr. William S. Boulton, professor of geology in the University of Birmingham; Lyell Medal to Dr. O. T. Jones, professor of geology in the University of Manchester; Wollaston Fund to Mr. A. L. Leach; Murchison Fund to Mr. W. S. Bisat; Lyell Fund to Mr. F. Raw and Mr. A. F. Hallimond.

AN International Photographic Exhibition in Esthonia is being organised by the Esthonian Photographic Club in Tallinn (Reval) on May 2-16. Exhibits will be arranged in five sections: (1) Artistic photography, (2) photography in natural colours, (3) applications to science and industry, (4) photomechanical processes, (5) literature. Applications to exhibit must reach the Club by March 15 and exhibits by April 15. An illustrated handbook of the Exhibition containing also articles of professional interest is to be issued.

AT the annual general meeting of the Royal Meteorological Society, held on January 20, the following officers and new members of council were elected: *President*, Sir Gilbert Walker; *Vice-Presidents*, Capt. C. J. P. Cave, Col. H. G. Lyons, Dr. G. C. Simpson, Mr. G. Thomson; *Treasurer*, Mr. Francis Druce; *Secretaries*, Mr. R. Corless, Commdr. L. G. Garbett, Major A. J. H. Maclean; *Foreign Secretary*, Mr. R. G. K. Lempfert; *New Councillors*, Mr. R. Arnison, Miss E. Elaine Austin, Dr. H. Jeffreys, Mr. I. D. Margary, Lt.-Commdr. E. C. Shankland.

Research Items.

THE ORIGIN OF THE AMERICAN INDIAN.—In the Smithsonian Report for 1923 (dated 1925), Dr. Aleš Hrdlička, after setting forth the grounds for his view that the American Indian is a race, homogeneous on the whole, which penetrated the continent from Asia through the north-west in relatively modern times, goes on to discuss the chronology of this intrusion and the relative priority of the various types of the Indian race. He points out that the remains, archæological and skeletal, of north-eastern Asia are of no great antiquity, but correspond generally to those of the Old World Neolithic age. The palæolithic remains of the Yenisei and north-western China are thousands of miles away from the point where man crossed to America. This leads to the presumption that man did not cross over before late Palæolithic or early Neolithic times. This would give a date of about ten or at most fifteen thousand years ago. Even if the unlikely hypothesis were accepted that man of north-eastern Asia had an independent development from European late Palæolithic or Neolithic man, his advent from southern Asia could not have been earlier than if he had come from the west. Mass migration being impossible owing to the difficulties of climate and food supply, the people must have passed over in small groups. Of these, the first would be the dolichocephalic Indian represented by the Algonquian, Iroquois, Sioux, and Shoshonean stocks which spread to Tierra del Fuego, including the Lagoa Santa race. Next came the "Toltec" type marked by brachycephaly, settling along the north-west coast and reaching as far as Peru. Later came the Eskimo and Athapascan, the former spreading over the far north and becoming the most highly specialised of American types, while the Athapascan, a virile brachycephalic type which may have preceded the Eskimo, is the most closely allied of all to the prevailing Mongolian type of north-eastern Asia. The path of the Athapascan was blocked and they remained in Alaska, except for a few who passed along the west coast to Mexico, where they left the Hupa, and to New Mexico, Arizona, Texas, and tracts of northern Mexico, where they are known as the Apache.

PREHISTORIC AMBER ROUTES IN EUROPE.—The relative rarity of amber, and the peculiarity of Baltic or northern amber generally owing to its high content of succinic acid, has opened an important line of archæological research in tracing ancient trade routes, based on discoveries of amber, between northern and southern Europe. In the *Geographical Journal* for December, Mr. J. M. de Navarro gives some of his conclusions. Evidence is not sufficient to warrant the assumption that there was a transcontinental trade in amber prior to the Bronze Age. Before that time the appearance of amber in the south was sporadic, and it probably came by sea. In fact, it was not unlikely the opening of the amber trade that led to the introduction of bronze to the north. During the middle Bronze Age, southern and western Germany seem to have played a larger part in the trade than Italy, yet it was probably through Italy that Baltic amber reached the Ægean world. There is not sufficient evidence to say that it came by way of Russia. During the early Iron Ages, the commerce with Italy grew, and consequently Italian influence in northern Europe was more direct. Italian amber was exploited at that period, but analysis of specimens warrants the belief that more of the amber in Italy came from the north, while a certain amount of inferior Italian amber was traded in Switzerland. Mr. Navarro believes that the amber trade culminated about the middle of the seventh century B.C. After that the eastern superseded the western routes and the trade lost importance.

CLIMATIC CHANGES AND THE WEGENER THEORY.—The Wegener theory receives warm commendation in an interesting article by Dr. G. C. Simpson on "Climatic Changes" in the January issue of the *Nineteenth Century*, on the ground that it "solves so many meteorological problems that it is difficult for meteorologists not to accept it." The most serious of these problems is the uniform world-wide climate during the Jurassic claimed by Prof. A. C. Seward from the plant evidence. This view Dr. Simpson describes as "entirely inexplicable" to the meteorologist. It is also inexplicable to the geologist in face of the evidence by the Jurassic faunas of well-marked climatic zones parallel to those of the present day, and of the refrigeration of the Jurassic climate toward the polar regions. The reef-building corals, for example, were then prolific in tropical and sub-tropical seas, but gradually disappeared toward the north. Dr. Simpson discusses the evidence for recent changes of climate, and agrees with Prof. J. W. Gregory's conclusions that there has been no progressive desiccation or permanent change of climate of the earth during the past 3000 years, though there have been local variations greater than those of the Brückner cycle. Dr. Simpson states that all subsequent work has confirmed Brückner's 35-year climatic oscillation; but as the irregular local changes exceed the Brückner variation, it is only apparent in records over an extensive area. Dr. Simpson suggests that the oscillation should be called the Brückner groups of cold and warm years rather than a cycle.

FUNCTIONAL DISEASES OF APPLES IN COLD STORAGE.—The Food Investigation Board publishes as Special Report No. 23 ("Functional Diseases of Apples in Cold Storage." By Franklin Kidd and Cyril West. Pp. vi + 15 + 13 plates. London: H.M. Stationery Office, 1925. 1s. net), a very useful summary of the various diseases known to occur to apples in cold storage. This report is based upon a paper by Drs. Franklin Kidd and Cyril West which was published in the *International Review of the Science and Practice of Agriculture*, which is now brought up-to-date and reprinted as a special report accompanied by an extensive series of photographs greatly facilitating recognition of the various diseases. Basing their views in part upon causal conditions involved in orchard conditions or cold storage practice, and in part upon methods of control, the authors recognise the following main types of disease: (1) Apple scald, a browning of the skin of the apple, a disease of the green skin, to which red and yellow skins are very resistant, which can be controlled by very efficient aeration or, still better, by wrapping the apple in a tissue paper that has been soaked in mineral oil. American investigators suggest that this disease is due to the accumulation of esters at the apple surface which are volatilised with efficient aeration or absorbed by the mineral oil. (2) Internal breakdown, a browning of the flesh of the apple which can be controlled by storing at somewhat higher temperatures than 32° to 34° F. (3) Brown heart, caused by excessive accumulation of carbon dioxide during storage (see NATURE, April 18, 1925, p. 584), which is avoided by preventing accumulation of carbon dioxide so high as 8 per cent. in the storage atmosphere. (4) Frost injury, usually local unless freezing has been severe. An interesting point recorded here is the relatively severe damage that is caused by bruising when the apples are in the frozen condition. The freezing point of the majority of apples appears to be between 28° F. and 30° F.

THE BRITISH FRESHWATER PEARL MUSSEL.—A short while ago (NATURE, July 25, 1925, p. 148) we directed attention to Part I. of Mr. J. Wilfrid Jackson's excellent address to the Conchological Society on "The Distribution of *Margaritana margaritifera* in the British Isles." Part II., now before us, which was announced to deal with the past history of the mollusc, does not, however, attain the same standard of excellence or add much to what little was known on the subject. The author points out that there is no definite proof of the occurrence of Margaritifera in pre-glacial times, and concludes that the species owes its presence to dispersal since glacial times, spreading gradually as the glacial conditions were passing away from areas untouched by the ice-sheets and gradually attaining its present distribution. Mr. Jackson summarises and discusses at some length the opinions of a limited number of writers on the glacial period and seems to conclude in favour of the post-glacial age of the greater part of the British fauna and flora. This to one with some fifty years' acquaintanceship with the subject has a distinct flavour of antiquity about it.

COLOUR VARIATIONS IN PARTRIDGES.—An exceedingly instructive series of colour variations in the red-legged partridges, *Alectoris rufa* and *A. saxatilis*, are described by Messrs. W. and G. Bateson (*Journ. Genetics*, vol. 16, No. 1). The "bright" variety of *A. rufa*, known as *melanocephala*, is represented by four specimens in the British Museum, all from the west of England, where four others have been seen. This form is also known from two records in different localities in Spain; and three specimens of the same variation in *A. saxatilis* were examined in Swiss museums, having all been taken within a radius of thirty miles. A "dull" variety of *A. rufa* is described under the name *obliterata*. It has a more nearly uniform coloration and is represented by three male specimens, all from the east of England. A black-headed species exists in Arabia under the name *A. melanocephala*, and this may be factorially significant. The dull, normal and bright forms are regarded as forming a series showing the progressive spread of barring. They are compared with the varieties of North American flickers, Colaptes, and with the barred patterns of the quagga and its relatives. As with Colaptes, a consistent factorial analysis of the differences is impossible without breeding experiments, because the colour-changes in different pterylæ appear to be, at least in part, independent of each other. The same problem is involved here as in the origin of many species which differ in several features of their colour patterns. Many South American parrots and parrokeets show similar differences, and it is to be hoped that some one will undertake breeding experiments with them, which might throw much light on the nature of all such variations.

THE ANATOMY OF PILA.—Vol. 8, No. 3 (1925), of the *Memoirs of the Indian Museum* is devoted to a description, by Dr. B. Prashad, of the anatomy of the common Indian apple-snail, *Pila globosa*, one of the Ampullariidæ which inhabits tanks, ponds, lakes, streams, and ricefields in the Gangetic plain, being particularly abundant where there is a large quantity of succulent aquatic vegetation. The various systems of organs are carefully described and references made to the histology. The functions of most of the organs are briefly noticed, *e.g.* the methods of respiration, aquatic and aerial, and short biological notes are added. The memoir will be found useful for comparative purposes.

CARBOHYDRATE/NITROGEN RELATION IN HORTICULTURE.—The *Journal of Pomology and Horticultural Science* for December contains an interesting review of recent American investigations on the importance of the carbohydrate/nitrogen balance in the plant, upon processes of growth and reproduction, which is written by Henry W. Hooker of the University of Missouri, who is himself an active worker in this field. This ratio is somewhat vague in connotation; carbohydrate is commonly used to include both insoluble polysaccharides such as starch, and reducing sugars, but not substances entering into the skeleton of the plant; there is some discussion as to whether soluble, insoluble or total nitrogen figures are more relevant. By various practical methods, as manuring, girdling, pruning, root pruning, and so on, this ratio can be definitely disturbed and in terms of the disturbance the effects upon growth and reproduction interpreted, though it is evident that the metabolic changes may be associated with, and yet not causal in relation to, growth and developmental changes. In fruit trees it has now been clearly demonstrated that in different parts of the tree this ratio may have a very different value and that the initiation of flower buds is associated with relatively high carbohydrate, whilst, on the other hand, fruit development seems associated with a rise in nitrogen in the fruit-bearing spurs.

THE ORIGIN OF THE ALPS.—In a paper recently read before the Royal Geographical Society, Prof. L. W. Collet gave a summary of recent ideas with regard to the evolution of the Alps. In a series of diagrams, to be published later in the *Geographical Journal*, he showed that in the embryonic Alps the foreland and hinterland of the chain constitute the boundaries of the great Alpine geosyncline diversified by included geanticlines. Through Carboniferous and Jurassic times these boundaries closed on and compressed the geosyncline like the jaws of a vice. The two geanticlines have developed into the two dominant nappes of the Alps, Great St. Bernard and Dent Blanche. Prof. Collet accepts as proved the forward drive of the hinterland towards the foreland. These conclusions, he points out, are in support of the Wegener hypothesis and indicate a northward drive of Europe, producing a distension to which the Mediterranean basin is due.

THE SPECIFIC HEAT OF ROCKS.—The effects of heat upon rocks are important not only geologically but also from the point of view of their fire-resisting properties. A valuable investigation which should not be overlooked has been carried out by T. Okaya, and the results are published in the *Japanese Journal of Astronomy and Geophysics*, vol. 3, No. 1, 1925. The specific heats of seventy-one different rocks are given, with a careful petrological description of each of the specimens tested. It is shown that the specific heat depends mainly on the chemical composition, but also in part on the structure. For practically all rocks the value lies between limits of 0·1 and 0·3. Among igneous rocks those rich in soda have higher values than those rich in potash. Sodic andesites, for example, range from 0·24 to 0·28, whereas potassic andesites range from 0·14 to 0·20. Crystalline limestones vary widely: from 0·19 for those poor in calcite to 0·26 and higher in the case of saccharoidal calcite marbles. Results are also recorded for tuffs and granites, and the paper is illustrated by eighteen excellent photo-micrographs.

AN AIR-PRESSURE SOUNDING MACHINE.—In the November number of the *Hydrographic Review*, there is a description of a self-recording sounding machine which depends on balancing the pressure of water on the sea-bottom by an equal pressure of air. The portion on the sea-bottom is an armoured sounding cable containing a flexible rubber tube. The lower end of the cable is provided with a jointed armoured covering which permits ready bending and promotes durability. The inboard end is secured by an air-tight joint to the hollow axle of the winding drum. An air-pressure pipe connects the axle, and therefore the tube of the sounding cable, with a pressure gauge on the bridge and with the compressed air reservoir. The recording devices consist of three dials and a bathygraph. The depth, at any moment, can be read on one of the dials. The other dials show the amount of cable out and the pressure in the air reservoir, while the time is recorded on a bathygraph. In practice the pressure in the reservoir is kept slightly higher than any water pressure expected, and the excess pressure is reduced by the escape of air from the bottom end of the sounding cable until the water pressure is balanced.

STOKES'S THEORY OF THE ABERRATION OF LIGHT.—The issue containing parts 11-14 of Vol. 58 (1925) of the *Rendiconti of the Royal Lombardy Institute of Science and Letters* includes a paper by Prof. G. A. Maggi replying to the objections raised to Stokes's theory of the aberration of light by Prof. Eddington in his communication on "Ether Drift and the Relativity Theory" published in NATURE of June 6 last. As regards the first objection—that the ether, with a velocity which is zero at sea-level and 10 kilometres per second at the height of Mount Wilson, would possess a rapid rotational motion, whereas Stokes showed that the movement of the ether should be irrotational—Prof. Maggi points out that actually Stokes postulated the irrotational movement to deduce his formula and that hence arose a difficulty indicated at the time by Lorentz in his paper on "Stokes's Theory of the Aberration in the Supposition of a Variable Density of the Ether" (*Proceedings of the Royal Academy of Sciences*, Amsterdam, 1898–1899, p. 443). The second and more serious objection advanced by Eddington is to the effect that, in contradiction to the more elementary notions of astronomy, the formula of Stokes indicates a variation of the aberration with the altitude. In this connexion Prof. Maggi observes that Stokes's formula furnishes the effective deviation, with respect to the terrestrial globe, of the light emitted from a star, from which, allowing for the degree of drag of the ether at any altitude, the aberration at that altitude is deduced.

RELEASE OF PRESSURE IN COAL-DUST EXPLOSIONS.—"The Effect of Release of Pressure on the Development of Coal-dust Explosions" is the subject of the second joint publication by the Safety in Mines Research Board and the United States Bureau of Mines (London, H.M.S.O., 3*d*. net). It describes a series of trials carried out at Eskmeals under Dr. R. V. Wheeler, the Director of the Station, and Mr. H. P. Greenwald of the Bureau of Mines staff. The experiments were made in the large steel gallery 750 feet long, open at one end and (normally) closed at the other. A cannon fixed 200 feet from the closed end was fired into a pile of fine coal-dust placed in front of it. Between the cannon and the open end, 550 feet away, fine dust was strewn partly on side-shelves and partly on the floor; no dust was laid behind the cannon. Along the gallery timing-screens and pressure gauges were fixed. The release of pressure was effected by substituting plates with circular holes cut in them for the solid plates which normally closed the gallery at three different places. (1) In the first place the release was made in the end plate 200 feet behind the cannon. When this was closed the maximum velocity of flame recorded near the mouth of the gallery was 2660 feet per sec. with a maximum pressure of 73 lb. per sq. inch. When this plate was a quarter open, little difference was observed; but with the end half open the pressure recorded was much less, although the flame came out at both ends of the gallery. With the rear end quite open the flame travelled slowly and only 2 lb. pressure was recorded. (2) When the openings for release were made just in front of the cannon, two small openings of one-sixteenth the area of the gallery had little effect on the velocity and pressure; but two one-eighth openings reduced the velocity to nearly one-quarter and the pressure to 3 lb. On moving the cannon just in front of the two one-eighth openings the velocity was high and the pressure rose to 23 lb. (3) When the openings were 200 feet in front of the cannon, the effect was to accelerate the initial flame, though the pressure recorded near the open end was not so high as when there was no release—and appeared to diminish as the flame proceeded. The nearer to the firing-point the release of pressure can be made, the greater is its effect in preventing a serious dust explosion.

ALCHEMICAL SECRET NAMES.—E. Wiedemann and J. Ruska have accomplished a very useful piece of work in giving a list of some Arabic alchemical "Decknamen" in a recent number of the *Beiträge zur Geschichte der Naturwissenschaften* (Sitzungsber. d. Physikalisch-Med. Sozietät in Erlangen, Band 56, 1924). It is well known that the Greeks, Syrians, Persians, Arabs, and others who, during 2000 years, busied themselves with alchemy, used "technical" or secret names for the substances they used in their operations. These names sometimes refer to noticeable properties of the bodies concerned (*e.g.* mercury, "the volatile slave"; copper, "the green one"; and so on), and sometimes are derived from mystical or religious associations, as when the metals are called by the names of the planets. Very often, however, they are purely arbitrary, so far as can be judged at the present day. The existence of this peculiar and variable system of nomenclature renders the translation of early chemical texts a matter of great difficulty, and the appearance of any list of synonyms—especially from the pen of Wiedemann and Ruska—is a matter for congratulation. The present paper is based mainly upon a manuscript work (Berlin, Ahlwardt's catalogue, No. 10361) of the celebrated poet, statesman, and alchemist Al-Tughrā'ī, entitled "The Book of the Precious Stone, upon the Art of the Elixir," but other sources have been drawn upon as well. First of all, the various names of the seven metals are given—no less than 23 for gold and about 60 for mercury!—then come the names of the seven "spirits" (mercury—also classed with the metals,—sal-ammoniac, realgar, orpiment, "yellow sulphur," "red sulphur," and "white sulphur"). Among the most interesting are the following: *Al-Kātib* (the scribe) and *Ḥayatu'l-Ajsād* (life of the metals), for mercury; *Al-Milḥ al-Ṭayyār* (the flying salt) and *Al-Filfil al-Armanī* (Armenian pepper) for sal-ammoniac; and *Ṭair Suqrâṭ* (the Bird of Socrates) for sulphur. A similar vocabulary, but with a larger proportion of Greek names, is given by the thirteenth-century author Abu'l-Qāsim al-'Irāqī in his book "Al-Kanz al-Afkhar," a MS. of which is preserved in the Royal Library at Cairo. Such lists are not only interesting in themselves; they also afford useful evidence concerning the transmission of chemical knowledge from one nation to another. Very noteworthy is the large number of Persian words used by Muslim chemists.

The Mathematical Association in Conference.

THE annual meeting of the Mathematical Association was held at the London Day Training College on January 4 and 5, with Prof. G. H. Hardy presiding. The report of the Council records continued growth in membership, and continued activity on the part of committees. The programme of the meeting consisted of three lectures and two discussions, in addition to the president's address.

Prof. E. N. da C. Andrade, whose subject was atomic structure, described the decomposition of a line spectrum into series, and Bohr's theory of the relation of these series to the constitution of the atom.

A lecture on modern theories of integration was in the nature of an experiment, and was brilliantly successful. After recalling the dual rôle of the integral in elementary work, Mr. Carey Francis showed the limitations imposed by any definition of the definite integral in which the only division of the range which is contemplated is a division into sub-intervals. He explained how the measure of a set of points extends the conception of the length of an interval, and introduced the Lebesgue integral and the Stieltjes integral as natural results of subdividing the range of integration into sets of points of any kind instead of into intervals only. Mr. Francis' achievement in making clear the nature and purpose of a mathematical method that was outside the curriculum in the student days of the majority of his audience seems to indicate a new and valuable function of the Association.

A forcible speech by Mr. E. R. Brown opened a discussion on the *Mathematical Gazette*, the organ of the Association; the remarks of different speakers emphasised the variety of tastes for which an editor may be asked to cater, without showing very clearly the sources from which he can draw.

Dealing with the measurement of intelligence, Prof. C. Spearman first illustrated the difficulty of reaching agreement either on a simple definition of intelligence or on the group of elementary qualities to be included in a composite definition. He afterwards explained the discovery that over a very wide range the observations can be systematised by the recognition of two factors, one which can be regarded as a measure of general intelligence and another which depends on the subject in which the individual is being tested.

The president's address was entitled "The Case against the Mathematical Tripos." Examinations have their place in education up to a certain point as natural and effective tests of industry and of the ability to learn and to reproduce, but the claim made for the Tripos has been that it assesses qualities of a higher order. Because of this claim and of the prestige of the Tripos, training for the examination has been substituted for genuine mathematical education, with the mischievous result to the individual that at any time it has been possible to obtain the highest honours while completely ignorant of all the broad developments of the previous thirty years, and to the nation that in no subject except music has the international position of England been so deplorable throughout two hundred years as in mathematics. Not only is it difficult to present in theory a plausible defence of the claim made for the Tripos, but in practice, position in the Tripos is ignored in all but an insignificant fraction of appointments, and if the Tripos is less harmful to English mathematicians now than fifteen years ago, that is because there is no distinction now which a good student does not obtain as a matter of course. Convinced that the best that can be said for the Tripos is, that so long as no attention whatever is paid to it either inside the University or outside, its ill effects are negligible, Prof. Hardy advised mathematicians at Cambridge deliberately to lower the standard at every opportunity, and so to reduce the examination to an absurdity the abolition of which must be only a matter of time.

Time was allotted for discussion of a "Report on the Teaching of Mathematics to Evening Technical Students," which has just been prepared for the Association; unfortunately, the report was not in the hands of members, and speakers could refer only to a synopsis distributed at the meeting, but interesting views were expressed on such matters as the value of deductive geometry for these students, and appropriate methods of introducing logarithms and the exponential function.

Agricultural Education in the United States.[1]

DURING the last half-century the importance of agricultural education has been increasingly recognised in America, until now every State has one or more agricultural colleges, forming a group of institutions occupying a prominent position in the field of education. During the decade 1910–1920 development was extraordinarily rapid, and very large sums of money were appropriated in many States for the provision of new agricultural buildings, the purchase of land, and the endowment of educational programmes. The colleges have had a long struggle for recognition, but have demonstrated their value and are now in such a position, financial and otherwise, that their future usefulness is assured. The immediate need is for trained teachers, investigators, and administrators, and in response to this, graduate work in agriculture has developed with amazing rapidity during recent years, though in certain colleges it is still seriously handicapped by lack of funds and accommodation. At present the full agricultural course extends over four years, but there is a suggestion to extend this to five in some cases for the purpose of specialised training. In many colleges the curricula have been steadily changed in order to keep abreast of the modern requirements of agricultural education, though there are still some in which the work is too largely restricted to methods of production, resulting in a narrowed outlook.

The field of work covered is very wide, ranging over at least a dozen branches, which, however, are not rigidly separated but dovetail into one another to some extent. All branches have developed from small beginnings, shaping themselves according to the needs of the time, with the result that some subjects which were originally an integral part of one branch are now dealt with more fully and adequately by others. Agronomy was initially defined as covering that part of the general field of agriculture devoted to climate, soils, fertilisers, and farm crops, but it now tends to deal with the more fundamental and far-reaching problems of soil physics and chemistry, plant physiology, and plant genetics. It is claimed that the instruction in agronomy has had much to do with securing the improved crop production of the United States in recent years. Horticulture has almost always

[1] Land Grant College Education, 1910–1920. Part III.: Agriculture. Edited by W. C. John. U.S. Bureau of Education Bulletin, 1925. No. 4. Pp. 105.

had a separate existence in the colleges, but with the growth of various interests, certain branches have developed until now they are treated independently, pomology and vegetable gardening being notable examples. With the better recognition of the importance of the forests to the nation, the instruction of forestry has advanced from exclusive concern with questions of afforestation to consideration of the vital problems of the proper protection, management, and perpetuation of existing stands of timber. The land grant colleges recognise their opportunity and responsibility to train the leaders with the necessary technique and with the broad outlook which will enable them to develop sound public policies of dealing with the forests and to establish right standards of practice. The general scheme of education keeps in view both the scientific and practical aspects of agriculture, and endeavours to emphasise the entire interdependence of the two. In addition to the branches already mentioned, special sections are devoted to soils and fertilisers, plant pathology, entomology, animal, dairy, and poultry husbandry, veterinary education, and agricultural engineering.

It is recognised that the four-year college course is not sufficient to supply the demand for trained workers on the land, partly because so large a percentage of graduates draft off into other occupations, as teachers, county agents, scientific workers, etc., and partly because a large proportion of those intending to farm cannot afford the time or money for a full college training. To meet the needs of the latter class, various types of short courses have been developed covering the various sections of the community concerned. The older boys and girls are catered for by special agricultural schools, farmers are provided with short courses extending over a few weeks only, at the slackest times of the year, and short schools are held for training specialists in such subjects as dairying, cotton culture, and ice-cream manufacture. In addition, courses in agriculture and horticulture are run for one, two, or three years, primarily for young men and women who intend to make farming their life work. Many problems have arisen in the development of these short courses, and special endeavours are made to solve them in such a way as to render the courses an integral and valuable part of the whole educational scheme.

During recent years a very marked development has taken place with regard to the professional training of teachers in agriculture. Special legislation has provided grants from Federal funds for the purpose, on the condition that equal sums are found by the States participating. The expenditure in this respect increased from 121,244 dollars in 1918 to 651,792 dollars in 1921, the growth of the work being so rapid that it was difficult for the land grant colleges to secure adequately prepared instructors for the purpose. Still more recently a demand has developed for courses in education designed to meet the needs of college instructors, and there seems little doubt that this part of the work will increase in relative importance. The same may be said of the agricultural extension work, which has steadily increased until in 1921 more than 18 million dollars were expended thereon, directly aiding the improvement of the farm and home practice of more than two million workers directly connected with the land, the whole of the extension work in 1920 costing 75 cents for each 1000 dollars of gross returns from agricultural production in the United States.

The Rainfall of Dry Periods in Relation to Water-power Schemes.

IN all questions relating to water-power schemes, some estimate of the water available is of first importance. Most schemes involve the storage of water in reservoirs, the size of which depends on the proposed draw-off compared with the run-off from the gathering ground in a dry period. Undoubtedly measurements of stream flow afford the best hydrological data upon which to base calculations. Such data are, however, often too short to give the average over a long period or the flow in the all-important dry period. Thus to a large extent calculations have to be based upon measurements of rainfall, compared where possible with gaugings of stream flow. It is, therefore, important to consider the relation of the average rainfall (1) to that of the period for which stream gaugings are available, and (2) to falls in dry periods in that area.

An investigation has been carried out on this subject by Capt. W. N. McClean,[1] who has analysed the monthly and annual rainfall figures for the fifty years 1871 to 1920 for thirty-five stations in Scotland. This mass of data is marshalled into a convenient graphical form, the unit of measurement of rainfall being expressed throughout in inches per annum, and the rainfall being plotted as the aggregate excess or deficiency from the average of the whole fifty years. The curves reproduced in the paper make it possible to read off :

(1) The actual rainfall of each calendar month and year;

(2) The lowest rainfall of each month and year; and

(3) The predicted lowest falls of periods of various lengths based on (2) above.

The fifty years, 1871 to 1920, were remarkable for the run of wet years in the 'seventies, the years 1872 and 1877 being the wettest in the series. The rainfall of the years 1886 to 1889, especially that of 1887, provided in many cases the lowest values in the period under discussion and would have severely taxed the storage capacity of the reservoirs. Outside the series, the year 1870 was as dry as 1887 over Scotland as a whole, while 1921 was noteworthy for the lowest annual totals on record in parts of the east of Scotland. Had these years, 1870 and 1921, been included in the analysis, lower values would certainly have been obtained in some instances and the smoothed enveloping curve of predicted values might have been modified.

One of the important facts brought out by the paper is that the rainfall at some stations is more variable year by year than at others, and this characteristic persists throughout the fifty years. The mean deviation of annual rainfall from the average is known to exceed 12 per cent. in central and south-eastern Scotland. This value diminishes towards the coast on all sides, but especially to the north-west, where, in islands to the west of Scotland, the value is only 8 per cent. This small variability factor in the rainfall of parts of Scotland is of considerable importance in connexion with the supply of storage reservoirs. In arriving at the predicted lowest values for each record, a factor is used based on the mean lowest value for the thirty-five gauges. Since there is this marked geographical variation, it would clearly be advantageous to use a factor varying with the geographical position of each individual station.

The curve of lowest predicted values is obtained from the one extreme value of the low rainfall for each of the periods of varying length. It is, however,

[1] "An Analysis of Scottish Rainfall Records." By W. N. McClean. Pp. 19+16 plates. (The Institution of Water Engineers, December 1925.)

essential to know the frequency of occurrence of low readings and whether any of them are fortuitous. Such information can be readily obtained from the mean deviation, which takes account of all the deficiencies in the series. This is another reason for including some such measure of the variability of the rainfall in the curve of the predicted lowest values.

This exhaustive analysis of Scottish rainfall is of particular importance in that the Western Highlands of Scotland provide a promising field for the further development of water-power schemes, having a large area with an average annual fall of more than 80 inches (reaching locally 150 inches) and a smaller factor of variability than most other areas in Great Britain.

The Spider Crabs of America.[1]

MISS RATHBUN has completed a very beautiful systematic monograph on the American spider crabs. It is a work of enormous labour, for no less than seventy-nine genera and nearly three hundred species are described, with minute details of their distribution and lists of the specimens examined from all localities. The figures are good photographs or clear diagrams and occupy nearly half the book, which is a most important contribution to the study of carcinology, and will be extremely useful to all systematists.

The companion volume is "The Grapsoid Crabs of America," forming Bulletin 97 of the United States National Museum, 1918, and here is to be found an introduction serving for both volumes, which are to be followed by others. The collections in the United States National Museum, embracing many hundreds of specimens, form the basis of both bulletins.

We have in the present volume a handbook for the study of American spider crabs which will be indispensable to workers in all countries. Some of these crabs have an extremely wide range of distribution; such are *Hyas araneus* and *Hyas coarcticus*, aptly termed "toad crabs," both of which are common on British coasts. *Hyas coarcticus*, which was originally described by Leach from British seas, is shown to have also a wide vertical range, extending from low water to (exceptionally) 906 fathoms.

The love of spider crabs for decoration is remarkable, and although in a work of this kind there is no room for details as to habits, still much may be learnt from it as to habitat and adaptation. Whether the animals actually decorate themselves with foreign substances or, without using them, are so like their environment that decoration is unnecessary, they are all so perfectly adapted to their surroundings that even in dead specimens one can usually recognise the kind of ground on which they live. The members of the Majidæ are the most important of the "masking crabs," but even among these there are some which do not cover their bodies with extraneous matter. Thus we have the bright red *Thoe puella* in the fringing shallows living on broken pieces of coral which have portions of sponge scattered over them of a similar colour to the crab; and the hairy *Mithrax verrucosus*—the hiding-place of which is in rocky holes covered with madrepores—which only comes out to feed at night. In the smaller family, Parthenopidæ, there are *Heterocrypta granulata*, the "pentagon crab," living on shingly bottom, bearing a striking resemblance to a freshly broken chip or flake of stone, and *Parthenope serrata*, which lives in the sand in shallow water with only the rostrum, eyes, and afferent apertures exposed, these apertures being situated between the base of the finger and the margin of the orbit.

There are very good diagrams showing the nomenclature of the parts as used in the monograph, and the descriptions of the crabs and the keys are all clear and easy to understand.

[1] Smithsonian Institution: United States National Museum. Bulletin 129: "The Spider Crabs of America." By Mary J. Rathbun. Pp. xx+613+283 plates. (Washington: Government Printing Office, 1925.) 2 dollars.

University and Educational Intelligence.

ABERDEEN.—Ordinances for the establishment of chairs in forestry and bacteriology have been approved of by Order in Council.

The Right Rev. E. W. Barnes, Bishop of Birmingham, has been appointed Gifford Lecturer for the period 1926–8.

CAMBRIDGE.—Mr. G. E. Briggs, fellow of St. John's College, has been reappointed as demonstrator in plant physiology. Mr. Briggs has in the past done effective research on carbon assimilation and growth.

The Royal Commission has issued amended regulations governing the initial appointments to be made under the new statutes.

Certain amendments to the regulations of the mechanical sciences tripos have been brought forward. The proposed changes are chiefly concerned with the regrouping and amendment of the "B" (advanced) papers, the special function of which is to grade the candidates.

The local nominees to the first committee of management of the new Polar Institute consist of the present Vice-Chancellor, and three antarctic explorers—Messrs. Debenham, Priestley, and Wordie. The Council of the Royal Geographical Society has nominated Dr. H. R. Mill as its representative.

A Gordon Wigan prize of 30*l*. has been awarded to Mr. F. H. Constable, fellow of St. John's College, for chemical research on "The Nature of Catalytic Action."

ST. ANDREWS.—The degree of D.Sc. has been conferred on Mr. James Forrest, lecturer in natural philosophy, University College, Dundee, for a thesis entitled "Magnetic Quality in Crystals; Part I., Magnetic Discrimination of Molecular Lattices; Part II., Stability of Molecular Lattices."

STERLING Fellowships for Research in the Humanistic Studies and the Natural Sciences at Yale University Graduate School have been established by a gift of 1,000,000 dollars from the trustees of the estate of the late John W. Sterling to stimulate scholarship and advanced research in all fields of knowledge. They are divided into two general classes: Research or Senior Fellowships, candidates for which must be of the standing of the Ph.D. degree; and Junior Fellowships, candidates for which must be well advanced in their work towards the Ph.D. degree. The annual stipends of the former range from 200*l*. to 500*l*. or more, dependent upon the character of the proposed investigation, and of the latter from 200*l*. to 300*l*. The fellowships are open equally to graduates of Yale University and other approved colleges and universities. Applications for the fellowships should be addressed to the Dean of the Graduate School of Yale University, New Haven, Connecticut, for Junior Fellowships, by March 1, and for the Senior Fellowships by April 1.

THE December number of the *University Bulletin* of the Association of University Teachers contains an article by Dr. Alex Hill, of the Universities

Bureau of the British Empire, on the promotion of "Interchange" of university teachers and students. By this phrase is meant temporary migration or short visits by teachers and students from the universities of Great Britain to those of another country for study, research, or teaching. The article traces the growth of the movement and its connexion with the growth of specialisation among universities from the year 1903, when, at a conference of universities, Lord Bryce pointed out that special opportunities of studying mining, forestry, and other branches of applied science were offered by the universities in the overseas dominions. The migration of British graduates to U.S.A. has received a substantial impetus in the past few years through the establishment of fellowships financed from America—especially the Commonwealth Fund fellowships founded last year. As regards migration of teachers, the article indicates that while the system established in many American universities of granting "Sabbatical" leave—furlough for an academic year after six years of service as professor—coupled with grants by the Institute of International Education of travelling allowances, makes the migration of American professors to Europe comparatively easy, the absence of any corresponding system in universities in Great Britain stands in the way of further development of migration by their professors, though it does not prevent them from paying visits of a few days' duration to continental universities. The faith of our universities in the benefits of interchange of professors has not yet availed to make them adopt the principle of the Sabbatical leave, even to the extent of announcing their willingness to grant such leave in the event of funds being provided to meet the expense involved.

THE prospectus for the year 1926–27 of the Imperial College of Tropical Agriculture, Trinidad, embodies a new feature in the form of the Principal's report, and a register of present and past students of the College has been inserted. The College has entered upon a new phase as the new buildings, the foundation of which was laid in January 1924, have now been opened by the Governor of Trinidad, and are in use. The Principal's report covers the academic year 1924–1925, the third year in the life of the College, and the first year of the term of office of the new principal, Dr. H. Martin Leake. The report indicates steady and useful progress both in the number of advanced and diploma students and in the amount and character of the research and investigation work that has been carried on. Full details of the courses of study in agriculture, botany, chemistry and soil science, economics, mycology, tropical sanitation and hygiene, veterinary science and zoology and entomology are given, and it will be seen that full provision is made to enable students to gain a very sound knowledge of tropical agriculture in all its branches. Reference is made to a hostel which is to be provided for students as soon as possible. A hostel will be needed all the more now that the Colonial Office has arranged to send students, under the Milner Scholarship Scheme, for a year's training in tropical agriculture before they take up their appointments in one of the Colonial agricultural departments. Though the importance of a hostel is fully realised by the governing body, funds, we understand, are not yet available for the purpose, and it is very desirable that Government and private benefactions should be made towards this very essential need of the College. The Imperial College has, we feel sure, so great a future before it that we commend the institution to the notice of all those who take an interest in the agricultural development of British Colonies.

Contemporary Birthdays.

January 29, 1845. Sir Robert Elliott-Cooper, K.C.B., Past. Pres. Inst.C.E.

January 30, 1851. Dr. Henry Ogg Forbes, F.R.G.S.

January 31, 1868. Prof. Theodore W. Richards, For. Mem. R.S.

Sir ROBERT ELLIOT-COOPER, born at Leeds, was educated there at the Grammar School, the headmaster of which at the time was Dr. (afterwards Bishop) Barry. Sir Robert's engineering pupilage began with the firm of Messrs. John Fraser of Leeds. Fifty years ago he settled in London to take up professional work. In 1912 he succeeded Prof. Unwin, F.R.S., as president of the Institution of Civil Engineers. His inaugural address dealt at length with the railways and works of the civil engineer in the overseas Dominions, the Crown Colonies, and the protectorates of the British Empire, many valuable statistics being brought together. During the War, Sir Robert was chairman of the War Office Committee of the Institution of Civil Engineers. He is a member of the executive committee of the National Physical Laboratory. It is interesting to note that Sir Robert's grandfather, when a young naval officer, sailed with Capt. Cook round the world, and was present at the discovery of Australia.

Dr. H. O. FORBES, traveller, anthropologist, museum curator, was born at Aberdeen. Educated at the city's grammar school, he proceeded to the Universities of Aberdeen and Edinburgh. He is LL.D. of the former. So far back as 1878, Dr. Forbes was exploring in Keeling Islands, Java, Sumatra and Timor, work which led to other undertakings in scarcely known lands. In 1885 he was chief of an expedition to explore Mount Owen Stanley, New Guinea. Director of the Canterbury Museum, New Zealand, 1890–93, he afterwards became Director of Museums to the Corporation of Liverpool. In various capacities he has proved a staunch helper to the British Association. Among many early memoirs, Dr. Forbes is the author of "On the Contrivances for ensuring Self-fertilisation in some Tropical Orchids"; "The Chatham Islands: their Relation to a former Southern Continent."

Prof. T. W. RICHARDS, Nobel laureate in chemistry, was born at Germantown, Pennsylvania. Son of a painter of landscapes and marine subjects, his mother was the author of various poetical works. She it was who conducted in the home Richards's early education, which was continued at Haverford College and Harvard University. Afterwards there was intensive study at Göttingen, Leipzig and Dresden Technical School. Becoming an assistant at Harvard in 1889, Prof. Richards is now Erving professor of chemistry and Director of the Wolcott Gibbs Memorial Laboratory, Harvard, U.S.A. The Nobel prize in chemistry for 1914 was allotted to him in recognition of his exact determinations of the atomic weights of a large number of the chemical elements. At the laureate ceremonies, Prof. H. G. Söderbaum, of Stockholm, said: "The work he has accomplished as a reformer of chemical methods and practices is by no means the least insignificant phase of his achievements." The Royal Society's Davy Medal had been awarded earlier. So too, the Chemical Society's Faraday Medal, given on the occasion of the Faraday lecture. "The solution," said Richards, "of the cosmic riddle is of the greatest importance to humanity, because only through a complete understanding of his own structure and that of his environment can man obtain control of the necessary conditions of his existence."

Early Science at Oxford.

February 1, 1683–4. Mr. Desmasters gave us an account of some experiments lately made by him, concerning ye expansion of Water frozen; he observed, that a cylindricall tube of $\frac{1}{4}$ of an inch diameter, being filled with water, to ye height of 2 inches, and set to freeze, in a mixture of snow, and salt; ye water, when perfectly frozen, appeared $\frac{5}{16}$ of an Inch above ye marke it stood at before ye freezing began. Another cylindricall tube of almost an inch diameter, being filled with water to ye height of 6 inches, and set to freeze as before; ye water in freezing rose $\frac{7}{8}$ of an inch; he observ'd farther, that when ye water thus set in snow and salt, began to freeze, a great number of small bubbles rose continually from ye bottom for some time. Mr. Ballard has observed of late, that half a pint of water frozen, lost ʒij—ʒij—grviij of ye weight it was of, before ye freezing; this experiment he tried a 2d time; ye success was much ye same, as at ye first. It was then queried, whether water, out of which ye air is pumpt, will rise in ye middle in the time of its freezing? and whether boiled water rises in freezing? Dr. Plot, and Mr. Ballard, undertook to trye these experiments.

Mr. Ballard gave an account of his success in trying some of Mr. Chamar's Experiments; whereas amongst other things Mr. Chamar says that Iron touched will loose its vertue, by being filed; Mr. Ballard says, this is true, if ye Iron be filed *all over*, not otherwise. Dr. Plot shewed some of ye Turkish *Rusma*, and *Alcanna*, which he lately received from Mr. Smith, Student of Christ Church, and chaplain to ye Factory at Smyrna, who wrote of ye use of ye Rusma, the *Alcanna* is ye leaf of a plant, dried, and powdered; which, when steept a night in wine, will die ye nails red; and I suppose ye gentleman means Smyrna, or such like wine, for (as Dr. Plot tells us) it will not succeed with Canary, or Claret.

Dr. Plot then proposed, and it was ordered by ye Society, that an exact account of ye weather should be kept, either according to Mr. Lister's, or some such compendious, method; and that at ye end of this, and other years, ye account of ye weather of preceding years, one or more, should be printed with an almanac for ye year to come.

February 1, 1686–7. An account was communicated by Mr. Musgrave of a way to preserve beef for three quarters of a year, and then half a year more after roasting.—An account of two high tides at London Jan. ye 28th, one 5 hours after the other.—An account of several extraordinary productions of a fœtus, bred out of a cat and a rat; the cat being the dam. This fœtus is now to be seen at the Earl of Abingdon's, as likewise a *Hirco-cervus* bred of a goat and a deer at ye same place. An account of several productions of a colour different from that of their species: e.g. of a white Ouzle or Black-bird, of white mice at one Mr. Tillyard's, an Apothecary in Oxford; of white Woodcocks, Partridges, Phesants, &c. seen by several of the Society.

February 2, 1685–6. A letter from Mr. Nicholson to Sir Wm. Dugdale concerning the Runic Inscription at Bridekirk was comunicated by Dr. Plot.—A Paper of Dr. Papin's explaining ye use of his Water Engine was also read.

February 3, 1684–5. Two letters from Mr. Cuningham, of St. Leonards College, were read: the latter of these mentions a way used in Scotland for ye cleansing mines of noxious vapors; the miners carry down a candle, in a dark lantern, covered with a wet cloth; then, lying flat on their faces, they, in that posture, kindle, and maintain a fire, which carryes off ye vapors, without injuring ye miners.

Societies and Academies.

LONDON.

Royal Society, January 21.—R. E. **Gibbs**: Structure of α quartz. Investigations on quartz have shown that symmetry and X-ray data enable only partial definition of structure. Intensity measurements and general physical properties of the material must also be studied. Oxygen atoms occupy positions $c/9$ above and below the silicon atoms. Only a small structural change accompanies the transition from β to α quartz, but still the tetrahedral character of β quartz is lost. The structure proposed assumes the crystal to be non-molecular and the oxygen to occupy basal planes as noted above. The silicon atoms seem to move about 0·3 Å.U. from their β-positions.—N. K. **Adam** and G. **Jessop**: The structure of thin films, Pt. vii. Critical evaporation phenomena at low pressures. By means of a new apparatus, measurements of the surface pressure of monomolecular films have been made at room temperature, down to 0·01 dyne per cm. At areas greater than about 5000 sq. Å.U. per molecule, the pressures exerted by films of insoluble fatty substances tend to a value within 25 per cent. of that given by the equation $Fa = RT$, R having the same value as in a perfect gas. The divergences from the theoretical values are probably within experimental error. Between 100 and 5000 sq. Å.U. the pressure-area isothermals closely resemble those for liquid and vapour in three dimensions. Expanded films are analogous to liquids, not vapours, and there is considerable cohesion between the molecules in them.—H. J. **Gough**, D. **Hanson** and S. J. **Wright**: The behaviour of single crystals of aluminium under static and repeated stresses.—C. H. M. **Jenkins**: The determination of the vapour tensions of mercury, cadmium, and zinc by a modified manometric method. The apparatus consists of a specially designed manometer, using the material under determination as the observed liquid in this gauge; it can be inserted in a 3-inch diameter electric tube furnace. The pressure on the apparatus is regulated by means of nitrogen, the pressure of which is measured on an independent barometer. The vapour pressure of the liquid is measured over a free surface in the closed end of the manometer by alterations in the pressure of the nitrogen to bring both liquid surfaces in this gauge level. The apparatus is similar to the letter V in shape. One extremity is closed; the other opens into a long straight column bent at right angles to it. Into this column specially shaped pieces are inserted, transforming it into a reflux condenser, which counteracts the diffusion of the nitrogen into the vapour. Values have been obtained for the vapour tensions of mercury, cadmium, and zinc over the range of pressure from 15 to 1500 mm. The boiling-points (760 mm.) have been found to be 357°, 767° and 906° C. respectively.—W. **Barlow**: The configuration of the carbon atom and the geometrical relations of this configuration to those of other atoms, as evidenced in the chemical and crystallographic structures of organic chemistry. Pt. i.—Ursula **Andrewes**, Ann C. **Davies** and F. **Horton**: The soft X-ray absorption limits of certain elements. Investigations have been made of the voltages corresponding to critical values of electron energy associated with some of the longer wave-length absorption stages of seven successive elements, chromium, manganese, iron, cobalt, nickel, copper and zinc. The generally accepted value of an absorption limit, obtained by spectroscopic methods, corresponds not to ionisation of the atom by the detachment from it of an electron in the sub-group concerned, but to the transportation of the electron from the sub-group to the periphery of the atom, *i.e.* to the levels of the most loosely bound electrons. The values obtained in this investigation are associated with absorption of energy by electrons in the M sub-groups, the several values obtained for each element being attributed to selective absorption stages, and not to actual ionisation of the atom.—W. L. **Bragg** and G. B. **Brown**: The crystalline structure of chrysoberyl. Chrysoberyl, $BeAl_2O_4$, is analogous in chemical composition to the spinel group of minerals $R''R_2''''O_4$. It is entirely different in its crystalline form, being orthorhombic, whereas the spinels are cubic. It may be supposed that the oxygen ions occupy the greater part of the volume in the crystal, and the metal ions are placed in the interstices between a close-packed assemblage of oxygen ions. A comparison of BeO, Al_2O_3, $BeAl_2O_4$, shows that in each case the oxygen atoms are very nearly in a close-packed hexagonal arrangement and that the distances between atomic centres are almost identical from the three crystals, being about 2·7 Å.U. Each aluminium atom in Al_2O_3 and $BeAl_2O_4$ occupies a position between six oxygen atoms. The hexagonal close-packed lattice can be referred to orthorhombic axes with ratios $\sqrt{2/3} : 1 : \sqrt{3/3}$.—H. G. **Telling**: On a set of quartic surfaces in space of four dimensions, and a certain involutory transformation. Each of the surfaces in four dimensions may be generated by taking three arbitrary skew lines and two arbitrary points, drawing a plane through each of the points to meet the three lines, and then finding the locus of the intersection of the plane through the first point with the plane through the second point. The geometry of the surface then suggests the consideration of, in all, fifteen lines, of which that joining the two given points is one; and then passing through an arbitrary given point of the space, there are fifteen such surfaces, one associated with each of the lines. The paper is concerned with determining the intersection of any two of these fifteen surfaces.—L. F. **Richardson**: Atmospheric diffusion shown on a distance-neighbour graph. The atmospheric diffusivity in Fick's equation has been found by various investigators to increase from 0·2 $cm.^2\ sec.^{-1}$ to $10^{11}\ cm.^2\ sec.^{-1}$ as the size of the cluster of diffusing particles increases from 10^{-2} to 10^8 cm. The effect is due to eddies of many sizes acting together. There is apparently no way of modifying Fick's equation in order to describe this phenomenon. But a new mathematical method is here developed, in which, instead of thinking about concentration as a function of position, we think about q, the mean number of neighbours per length, as a function of l, their distance apart. This gives a rough average value $0{\cdot}6\ l^{4/3}$ $cm.^2\ sec.^{-1}$ for the atmosphere, when l lies between 1 metre and 10 km.—T. **Alty**: Some phenomena occurring at the surface of bubbles in water. The surface tensions of water in contact with various gases are compared by the drop-weight method. The weight of a bubble is independent of the gas used if the rate of flow is slow enough. To examine a new water surface, the rate of flow is increased until several bubbles emerge per second. When flowing from the same capillary, the gases form bubbles the volumes of which can be arranged in decreasing order as follows: argon, nitrogen, oxygen, ozone, hydrogen, nitric oxide, carbon dioxide. These differences are related to the adsorbability of the gases.—A. L. M. **Sowerby** and S. **Barratt**: The line absorption spectra of the alkali metals. The alkali metals are all able to absorb the lines of the combination series 1*s*-*md*, contrary to the Selection Principle. The cæsium series of this type has been observed for the first time. The absorption of this series by potassium is uninfluenced by the presence of argon at two atmospheres pressure. It is estimated that 12,000 times as many atoms can absorb the first member of the principal series of potassium and rubidium as can absorb the line 1*s*-3*d*, the ratio being the same for the two metals. The "atomic extinction coefficients" of the different alkali metals are approximately the same for corresponding lines.—A. M. **Tyndall** and G. C. **Grindley**: The mobility of ions in air. Pts. i. and ii. The improved method of measuring mobility depends on producing ions by flashes of α-rays subjected to a special alternating field. The effect of water vapour is to cause fall of mobility of fully formed negative ions down to a value 1·6 in saturated air. Positive ions of two types were found—initial and final. The mobility of the initial type is indistinguishable from that of the negative and is similarly affected by water vapour. Water vapour has a retarding influence on rate of transformation into final ions. In ordinary dry air much transformation occurs within 0·007 sec. of birth, but in wet air the ions nearly all remain in the initial stage at double this age.—W. **Jevons**: A band spectrum of tin monochloride exhibiting isotope effects. The spectrum of the uncondensed discharge through $SnCl_4$ vapour comprises a continuous spectrum between λ 4900 and λ 3950, and a hitherto unrecorded band spectrum consisting of two distinct sets of bands occupying the regions λ 3910 – λ 3486 and λ 3405 – λ 2830 respectively. Each set is attributed to a chloride of tin. The bands in the more refrangible set constitute two systems α and β of the normal Deslandres type. If they be ascribed to $SnCl^{35}$, a few additional bands in the same region are attributable to $SnCl^{37}$. There is also some indication of the tin isotope effect. The less refrangible set consists of several groups, each containing a few close bands degraded towards the red. Too little is known of these bands to say whether they are emitted by SnCl or by a polyatomic chloride.—J. H. **Andrew**, M. S. **Fisher** and J. M. **Robertson**: Some physical properties of steel and their determination. Methods of measuring electrical resistance, electrode potential, and continuous change of resistance during tempering, are described. The change from martensite to granular pearlite is gradual and only proceeds to a certain stage at each temperature. Martensite is not formed during tempering at constant temperature, but results from the decomposition of austenite during cooling from the tempering temperature. The rate of tempering of martensite is not affected by the addition of moderate amounts of special elements. Austenite tempers more slowly, and its rate of tempering is considerably reduced by addition of special elements.—N. K. **Adam** and G. **Jessop**: Note on the spreading of solids on water surfaces. Cary and Rideal's observations on the spreading of myristic acid on water have been continued down to very low compressions. A small pressure, that of the "gaseous" state of the film, is set up immediately the crystal touches the surface, and the "two-dimensional vapour pressure" very soon afterwards.

Royal Microscopical Society, December 16.—F. I. G. **Rawlins**: The theory of dimensions in microscopy. The fundamental quantities of interest to the microscopist, such as the power of a lens, curvature, numerical aperture, resolution, convergence, are considered from a dimensional point of view. A number of magnitudes in common use for interference work are discussed dimensionally, and the importance of the inclusion of the appropriate constants of proportionality when dealing with geometrical properties is stressed.

EDINBURGH.

Royal Society, January 11.—A. Anstruther **Lawson**: The origin of endemism. The vast continental, insular flora of Australia, with 70 per cent. of its species and 30 per cent. of its genera endemic, is perhaps the most favourable of all fields for the study of endemism. From a study of their habits, habitat, foliage, variability, great profusion of flowers, sterility of flowers, and low percentage of seed set of the main endemic types, which is so characteristic, it seems at least the majority are hybrids. Hybridisation seems to occur in the Australian flora wherever possible, and the possibilities are quite general. The endemic flora had its origin as hybrid mutations derived in the first place from non-endemic types. Hybrid mutations—followed by natural selection—has been the main determining factor and influence in the evolution of the Australian flora. Such conclusions are directly opposed to the theory of De Vries and to the Morgan School in America.—G. Gordon **Harrower**: A study of Ho-kien and Tamil skulls. The Ho-kien, native of the Chinese province of Foo-kien, differs in certain particulars from that of the northern Chinese, and represents a more or less pure strain of the indigenous Mongolian type which preceded the Chinese in south-eastern Asia. Comparisons reveal certain affinities with one type of Tibetan skull—a point of interest in connexion with the question of origins. The sample of Tamil skulls collected represents one group of the indigenous Dravidians of southern India. The skull is relatively long and narrow, and is high; the face is low and relatively broad, and the nasal aperture is only moderately broad in proportion to the height. The skull differs in several particulars from European skulls of the same class, notably in the smaller expansion of the occiput; it shows no admixture with the intrusive Aryan element.—D. A. **Fairweather**: Electrosynthesis in the series of normal dibasic acids. Three new acids of this series have been synthesised by Crum Brown and Walker's electrosynthetic method, namely, those with 20, 24 and 28 methylene groups.—C. C. **Miller**: The slow oxidation of phosphorus trioxide Pt. i. The action of water vapour on phosphorus trioxide. The oxidation of phosphorus trioxide to pentoxide by oxygen at low temperatures (25°) is accompanied by luminescence, and only takes place in the presence of water vapour, the pressure of which need only be very low. In the absence of oxygen it was found that at 25°, under certain conditions, comparatively large quantities of gaseous and liquid phosphuretted hydrogen were produced, which may play a part in the oxidation when oxygen is present.—E. T. **Copson**: Partial differential equations and the calculus of variations. The conditions under which a linear partial differential equation of the second order may be derived by annulling the variation of an integral are determined. The self-adjoint equation is shown to be a particular case. Systems of equations are also discussed.

ROME.

Royal Academy of the Lincei, November 15.—T. **Levi-Civita**: Gravitational movements in one dimension.—G. **Armellini**: Theory of the flying shadows in solar eclipses. The shadow bands moving in front of, and parallel to, the lunar shadow during total solar eclipses are regarded as an ordinary diffraction phenomenon.—F. **Zambonini** and G. **Carobbi**: Double sulphates of rare earth and alkali metals (iv.). Double sulphates of neodymium and sodium. Compounds containing $Nd_2(SO_4)_3$, Na_2SO_4, and H_2O in the respective molecular proportions 1 : 1 : 2, 4 : 5 : 8, 3 : 4 : 6, and 2 : 3 : 5 have been obtained as pale violet-red crystals.—F. **Zambonini** and R. G. **Levi**: Isomorphism of molybdates of the rare earth metals with those of calcium, strontium, barium, and lead (iv.). Structure of the molybdates of lanthanum, cerium, praseodymium, neodymium, and samarium.—L. **Sabbatani**: Pharmacological action of iron with double and complex salts.—S. **Franchi**: Geological problems in the Franco-Italian Alps.—L. A. **Herrera**: Imitation of cell-division and spore-germination by means of calcium fluosilicate.—G. **Tizzoni**, E. **Centanni**, and G. **De Angelis**: Modifications produced by radium in the substance of the cancer tumour of the young rat, and its transformation into a curative vaccine.—W. **Blaschke**: Cyclic systems of curves on a surface.—Antonio **Signorini**: A theorem of existence and singularity in the statics of materials exhibiting low resistance to tension.—Bruno **Finzi**: Potential laminary liquid motions on developable surfaces.—Rita **Brunetti**: Relative magnitude of atoms and ions.—A. **Pontremoli**: A characteristic experiment in electric or magnetic double refraction.—G. R. **Levi**: The varieties of thorium oxide and their catalytic action in the dehydration of alcohol. The so-called meta-oxide of thorium is crystalline and identical with the normal oxide, whereas the thorium hydroxide usually obtained is amorphous and undergoes transformation into an amorphous oxide stable at temperatures higher than 300°. The catalytic influence of the oxide on the dehydration of alcohol is not affected by its crystalline or amorphous character.—Raoul **Poggi**: Some derivatives of toluene.—C. **Sandonnini**: Actions in the presence of carbon.—Paolo **Principi**: Observations on the geology of the upper and middle valleys of Savio.—Beatrice **Torelli**: The significance of heterochromosomes.—Umberto **D'Ancona**: Influence of salt solutions on the resistance of young eels to fasting.—Remo **Grandori**: Studies on the blastokinesis of insects.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 11, No. 12, December 1925).—George H. **Shull**: The third linkage group in Œnothera. A mutation called "old-gold" (*vetaurea*) found in *Œ. Lamarckiana* is the first discovered factor of a third linkage group. Another factor of the same group, "double" flowers (called mutant *supplena*), is now announced.—Horace W. **Feldman**: Fertility of the rat, *Mus norvegicus*. Fertility in the Norway rat is generally dependent on the vigour of the female. The size of litter increases to a maximum at the age of 150-179 days and decreases afterwards to a minimum, due apparently to the decrease of general vigour with age. Inbreeding increased the frequency of still-births. Seasonal fluctuations occurred: litters showed an average maximum (7·3 young) in June, decreasing to a low point (5·2 young) in October and increasing again in November and December.—Tracy Yerkes **Thomas**: Invariants of relative quadratic differential forms.—R. L. **Wilder**: A property which characterises continuous curves. A continuous curve is a bounded continuum connected *im kleinem*, and such curves are characterised by being "normally connected."—Carl **Barus**: Telephonic coupling of acoustic and electrical oscillations evidenced by the pinhole probe.—J. C. **Slater**: Interpretation of the hydrogen and helium spectra. Pauli has suggested that the double levels in atoms having one valence electron have some connexion with a duality in the quantum laws. This would lead to resemblances between the spectra of hydrogen and helium and those of the alkalis and alkaline earths respectively. Evidence of this is adduced.—J. G. **Winans**: Radiation emitted by optically excited zinc vapour. Zinc vapour in a quartz "resonance" tube was illuminated by a water-cooled zinc arc maintained in a quartz tube. Thirteen lines were detected in the spectrum observed and accounted for; in addition, four bands appear which are more intense relative to the lines in the optically excited radiation than in that from the zinc arc. Mercury as an impurity in the zinc vapour gives evidence of "impact fluorescence."—Ernest **Merritt**: On contact rectification by metallic germanium. Rectifying properties were observed, the contact being stable, and the behaviour at different points fairly uniform. Making contact with bismuth gives anomalous results. Platinum was also used and the temperature raised. The resistance of the contact becomes much smaller, and at 220° C. it was the same in both directions through the contact. On cooling, the resistance remained greater than it was before heating, due apparently to a highly resistant film of oxide.—Henry Fairfield **Osborn**: The origin of species (ii.). Further detailed statements are made on some of the nine bio-mechanical principles of adaptation enunciated in an earlier paper (NATURE, June 13, 1925, p. 925, and June 20, 1925, p. 961).—Raymond **Pearl**: Vital statistics of the National Academy of Sciences. (i.) Age at election. The original membership was of high average age; of the 48 charter members, only 4 were less than 38 years old. During the period 1864–83, the mean age at election was 44·47 years; for 1884–1904, it increased to 46·54 years; and for 1905–1924, another four years were added. Of the 213 elected during this last period, only 8 were less than 38 years old. These figures show the same tendency as the statistics of the Royal Society. (ii.) Elections of young men. 43 persons, including 2 charter members, were less than 37 years old at election. Of these, 30 worked at the physical and 12 at the biological sciences. The youngest man elected was the astronomer, E. C. Pickering (26·8 years), and the next youngest, the engineer, Fairman Roger, charter member (29·3 years). (iii.) Mortality. At 40 years of age, members of the Academy have a mean after lifetime more than five years greater than that of urban white males of the United States, and some increased expectation is maintained up to the age of 85 years. This might be expected, since they belong to the occupational groups giving superior risks from the life insurance viewpoint. (iv.) The present limitation to total membership and other matters. With living membership of 221, 15 elections, and an average of 8 deaths annually, the Academy will reach its limit of 250 members in 1929; thereafter, the mortality will allow of the election of 6 to 8 members a year. The present mean age of members is $60{\cdot}74 \pm 0{\cdot}47$ years; their mean duration of service is $12{\cdot}17 \pm 0{\cdot}48$ years, and that of members who have died was $19{\cdot}57 \pm 0{\cdot}60$ years.—Marston Taylor **Bogert** and Hugh Blake **Corbitt**: Researches on thiazoles (x). The synthesis of some 2-phenyl-benzothiazole arsonic acids. These compounds are important therapeutically, for one of them has a greater action on *Tr. equiperdum* and greater toxicity for white rats than the corresponding benzene compound, but there was no evidence of any effect on the nervous system such as is frequently caused by penta-valent arsenic compounds.—S. C. **Lind**: The origin of terrestrial helium and its association with other gases. Helium is very generally distributed in natural gases, but in widely different concentrations (maximum nearly 4 per cent.). It is not confined to limited geological horizons, suggesting that its occurrence in quantity is due to prevention of leakage by a gas-seal, such as a capping of shale containing clay. A radioactive origin is favoured. It is always found with high though variable nitrogen content, possibly due to the action of the initial α-particle producing nitrogen and helium simultaneously, from some nitrogen compound in the parent mineral.

Official Publications Received.

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report, East Malling Research Station, 1st January 1924 to 31st December 1924. Pp. 216. (East Malling.) 5*s*.

Egyptian Government: Anti-Malaria Commission. The Mosquitoes of Egypt. By T. W. Kirkpatrick. Pp. xii+224+24 plates+2 maps. (Cairo: Government Publications Office.) 30 P.T.

Union of South Africa: Department of Agriculture. Science Bulletin No. 38: Report on the Cost of Production of Maize Investigation for the Season 1922–23. By E. Parrish. Pp. 30. 3*d*. Science Bulletin No. 41: Note on the Storage of Eggs. By E. A. Griffiths, D. J. R. de Villiers and Leitch Anderson. Pp. 16. 3*d*. Science Bulletin No. 42: (i) Further Investigations into the Causes producing Rosette of Apricot and Plum Trees in the Wellington District; (ii) Report on some Preliminary Investigations into the Influence of Alkali Soils on Peach Stocks employed for Apricot and Plum Trees. By Dr. R. Marloth. Pp. 30. 3*d*. (Pretoria: Government Printing and Stationery Office.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 1: National Bureau of Standards; its Functions and Activities. Second edition. Pp. vi+113. (Washington: Government Printing Office.) 50 cents.

Proceedings of the Society for Psychical Research. Part 96, Vol. 35, December. Pp. 471-594. (London: Francis Edwards.) 7*s*. net.

South Australia. Annual Report of the Director of Mines and Government Geologist for 1924. Pp. 8. (Adelaide: R. E. E. Rogers.)

University of Illinois Engineering Experiment Station. Bulletin No. 151: A Study of Skip Hoisting at Illinois Coal Mines. By Prof. Arthur J. Hoskin. Pp. 66. (Urbana, Ill.) 35 cents.

Madras Agricultural Department. Year Book, 1924. Pp. 94. (Madras: Government Press.) 14 annas.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1924–25. Pp. 51+5. (Madras: Government Press.) 4 annas.

Agricultural Research Institute, Pusa. Bulletin No. 161: List of Publications on Indian Entomology, 1924. (Compiled by the Imperial Entomologist.) Pp. ii+41. 8 annas; 9*d*. Bulletin No. 163: Loss of Sugar by Inversion in Sugar Factories in Northern India and its Prevention by Antiseptic Measures. By C. M. Hutchinson and C. S. Ramayyar. Pp. ii+9. 2 annas; 3*d*. (Calcutta: Government of India Central Publication Branch.)

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 3. Pp. viii+165. (Paris: Les Presses universitaires de France.)

Société des Nations: Organisation d'hygiène sous-comité du Cancer. (League of Nations: Health Organisation Sub-Committee on Cancer.) Rapport sur les résultats des enquêtes démographiques dans certains pays. (Report on the Results of Demographic Investigations in certain selected Countries). C.H. 333, Vol. 1. Pp. 168. Rapport sur les résultats de certaines enquêtes cliniques se rapportant aux différences de mortalité cancéreuse dans certains pays choisis spécialement. (Report on the Results of certain Clinical Enquiries relating to Differences of Cancer Mortality in certain selected Countries.) C.H. 333, Vol. 2. Pp. 39. (Genève: Société des Nations; London: Constable and Co., Ltd.)

The Observer's Handbook for 1926. Edited by C. A. Chant. (Eighteenth Year of Publication.) Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

Ministry of Public Works, Egypt: Physical Department. An Experiment to Determine Corrections to Sounding in River Gauging. By Dr. P. Phillips. (Physical Department Paper No. 18.) Pp. 26+20 plates. (Cairo: Government Publications Office.) 5 P.T.

University of Adelaide. Publications under the Keith Sheridan Foundation, No. 1: Dentition and Palate of the Australian Aboriginal. By Dr. T. D. Campbell. (Thesis presented for the Degree of Doctor of Dental Science.) Pp. viii+123+53 plates. (Adelaide.)

The Marine Biological Station at Port Erin (Isle of Man): being the Thirty-ninth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 40. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1*s*. 6*d*. net.

The Manchester Museum. Notes from the Manchester Museum, No. 28: Some Collembola from Southern New Zealand. By Dr. George H. Carpenter. (Museum Publication 89.) Pp. 16. 2*s*. Report of the Museum Committee for the Year 1924–25. (Museum Publication 90.) Pp. 19. 6*d*. net. Notes from the Manchester Museum, No. 29: The Distribution of Margaritana Margaritifera in the British Islands. By J. Wilfrid Jackson. (Museum Publication 91.) Pp. 10. 1*s*. 6*d*. (Manchester.)

National Museum of Wales. Guide to the Collections of British Lepidoptera. Pp. 31+2 plates. (Cardiff.) 6*d*.

Canterbury College (University of New Zealand). Records of the Canterbury Museum. Vol. 2, No. 5. Pp. 269-329 + plates 41-47. (Christchurch, N.Z.)

Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation, 1925. Annual Report of the Naval Observatory for the Fiscal Year 1925. Pp. 21. (Washington: Government Printing Office.)

Annuaire pour l'an 1926 publié par le Bureau des Longitudes. Pp. viii+665+A138+B131+C68. (Paris: Gauthier-Villars et Cie.) 8 francs.

The Indian Forest Records. (Entomology Series), Vol. 12, Part 2: Identification of Immature Stages of Indian *Cerambycidae I. Cerambycini.* By J. C. M. Gardner. Pp. 17+3 plates. (Calcutta: Government of India Central Publication Branch.) 8 annas; *9d.*

Field Museum of Natural History. Zoological Series, Vol. 13: Catalogue of Birds of the Americas and the adjacent Islands in Field Museum of Natural History; including all Species and Subspecies known to occur in North America, Mexico, Central America, South America, the West Indies and Islands of the Caribbean Sea, the Galapagos Archipelago, and other Islands which may be included on account of their Faunal Affinities. Initiated by Charles B. Cory; continued by Charles E. Hellmayr. Part 4: Furnariidae—Dendrocolaptidae. (Publication 234.) Pp. iv+390. (Chicago.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 1: A Study of some Indian Grasses and Grasslands. By Dr. W. Burns, L. B. Kulkarni and S. R. Godbole. Pp. v+57+4 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s.* 3*d.*

Air Ministry: Meteorological Office. International Meteorological Organization: Commission for the Exploration of the Upper Air. Report of the Meeting in London, April 16-22, 1925. (M.O. 281.) Pp. 79+2 plates. (London: H.M. Stationery Office.) 2*s.* net.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 1, No. 3: The Diffusion of Salt Vapours in a Bunsen Flame. By Fred. J. Symon. Pp. 15-19. 6*d.* Vol. 46, Part 1, No. 4: Researches into the Characteristic Numbers of the Mathieu Equation. By Dr. E. L. Ince. Pp. 20-29. 1*s.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Union of South Africa. Journal of the Department of Agriculture. Vol. 11, No. 6, December: The Annual Report of the Department of Agriculture for the Year ended 30th June 1925. Pp. xxxvi+469-636. (Pretoria: Government Printing and Stationery Office.) 6*d.*

South Australia: Department of Mines. Mining Review for the Half-year ended June 30th, 1925. (No. 42.) Pp. 89+5 plates. (Adelaide: R. E. E. Rogers.)

Scientific Papers of the Institute of Physical and Chemical Research. Vol. 1, No. 1: Band Spectra of Mercury. By Hantaro Nagaoka. Pp. 6+1 plate. n.p. Vol. 1, No. 2: On the Chemical Constituents of Squalene. By Riko Majima and Bennosuké Kubota. Pp. 7-21. 30 sen. Vol. 1, No. 3: On the Nature of Graphite and Amorphous Carbon. By Genshichi Asahara. Pp. 23-30+1 plate. 30 sen. Vol. 1, No. 4: A Study on the Reducing Action of Ferrous Hydroxide. By Susumu Miyamoto. Pp. 31-56. 25 sen. Vol. 1, No. 5: On the Detection and Separation of Indium. By Isaburo Wada and Sunao Ato. Pp. 57-77. 35 sen. Vol. 1, No. 6-7: Absorption of Moisture by Fibrous Insulating Materials, by Tsunetaro Kujirai, Yôzô Kobayashi and Yotsuo Toriyama; Effect of Humidity on the Electrical Resistance of Fibrous Insulating Materials, by Tsunetaro Kujirai and Takeo Akahira. Pp. 79-124. 65 sen. Vol. 1, No. 8: The Band Spectra and the Electronic Configuration of Nitrogen and Carbon Monoxide Molecules. By Hantaro Nagaoka. Pp. 125-134. 20 sen. Vol. 1, No. 9: On a Microbarograph. By Hantaro Nagaoka and Naoshi Ayabe. Pp. 135-138+2 plates. 25 sen. Vol. 1, No. 10: On a new Method of Separation of Iridium from Rhodium and Platinum, and the Separation of Platinum and Rhodium. By Isaburo Wada and Tamaki Nakazono. Pp. 139-154. 25 sen. Vol. 1, No. 11: On the Regularity in the Distribution of Spectral Lines of Iron and Intra-atomic Magnetic Field. By Hantaro Nagaoka and Yoshikatsu Sugiura. Pp. 155-206. 35 sen. (Komagome, Hongo.)

Report on Norwegian Fishery and Marine Investigations. Vol. 3, No. 4: Frequency Curves in Herring Investigation. By Einar Lea, Pp. 27. Vol. 3, No. 6: On the Growth of the Cod and the Formation of Annual Zones in the Scales. By Alf Dannevig. Pp. 24+13 plates. (Bergen: A.S. John Griegs Boktrykkeri.)

British Museum (Natural History). Coloured Postcards. Set E29, Exotic Butterflies, Series No. 4. 5 cards in colour, 1*s.* Set E30, Exotic Butterflies, Series No. 5. 5 cards in colour, 1*s.* Set E31, Exotic Moths, Series No. 7. 5 cards in colour, 1*s.* Set E32, Exotic Moths, Series No. 8. 5 cards in colour, 1*s.* Set E33, Exotic Beetles, Series No. 2. 5 cards in colour, 1*s.* Set E34, Exotic Beetles, Series No. 3. 5 cards in colour, 1*s.* Set E35, Exotic Homoptera, Series No. 3 (Bugs). 5 cards in colour, 1*s.* Set E36, Exotic Heteroptera, Series No. 1 (Bugs). 5 cards in colour, 1*s.* Set E37, Exotic Orthoptera, Series No. 2 (Cockroaches, Stick-Insects and Grasshoppers). 5 cards in colour, 1*s.* Set E38, Exotic Orthoptera, Series No. 3 (Grasshoppers). 5 cards in colour, 1*s.* (London: British Museum (Natural History).)

Bulletin of the American Museum of Natural History. Vol. 52, Art. 3: The Gulls (Laridæ) of the World; their Plumage, Moults, Variations, Relationships and Distribution. By Dr. Jonathan Dwight. Pp. 63-401+plates 11-15. (New York.)

Bulletin of the University of Wisconsin. Serial No. 1270, General Series No. 1048: Phytoplankton of the Inland Lakes of Wisconsin. Part 2: Desmidiaceae. By Gilbert Morgan Smith. (Wisconsin Geological and Natural History Survey, Bulletin 57, Part 2.) Pp. ii+227. (Madison.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1924. (Publication 2795.) Pp. xii+535+103 plates. (Washington: Government Printing Office.) 1.75 dollars.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 25: Flora of Utah and Nevada. By Ivar Tidestrom. Pp. 665+15 plates. (Washington: Government Printing Office.) 80 cents.

Smithsonian Institution: United States National Museum. Bulletin 100, Vol. 2, Part 4: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. Silicious and Horny Sponges collected by the U.S. Fisheries Steamer *Albatross* during the Philippine Expedition, 1907–10. By Prof. H. V. Wilson. Pp. vii+273-532+plates 37-52. (Washington: Government Printing Office.) 35 cents.

Department of the Interior: U.S. Geological Survey. Bulletin 771: Ore Deposits of the Saddle Mountain and Banner Mining Districts, Arizona. By Clyde P. Ross. Pp. vii+72+17 plates. 25 cents. Bulletin 773: Mineral Resources of Alaska; Report on Progress of Investigations in 1923. By A. H. Brooks and others. Pp. iii+267+xv+6 plates. 40 cents. Bulletin 774: The Copper Deposits near Salmon, Idaho. By Clyde P. Ross. Pp. iv+44+5 plates. 15 cents. (Washington: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 547: Surface Water Supply of the United States, 1922. Part 7: Lower Mississippi River Basin. Pp. iv + 106 + 2 plates. 15 cents. Water-Supply Paper 560-D: Preliminary Report on the Geology and Water Resources of the Mud Lake Basin, Idaho. By H. T. Stearns and L. L. Bryan. Pp. iv+87-134+2 plates. n.p. (Washington: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 38: Procès-verbaux (Septembre 1925). Pp. 92. Publications de Circonstance, No. 89: The Herrings along the Baltic Coast of Sweden. By Chr. Hessle. Pp. 54+3 maps. (Copenhague: Andr. Fred. Høst et fils.)

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1924–25. Pp. 164. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

Jamaica. Annual Report of the Department of Science and Agriculture for the Year ended 31st December 1924. Pp. 42. (Jamaica: Government Printing Office, Kingston.)

University of Illinois Engineering Experiment Station. Bulletin No. 152: An Investigation of the Fatigue of Metals, Series of 1925; a Report of the Investigation conducted by the Engineering Experiment Station, University of Illinois, in coöperation with the National Research Council, the Engineering Foundation, the General Electric Company, the Allis-Chalmers Manufacturing Company, the Copper and Brass Research Association, the Western Electric Company. By Prof. H. F. Moore and Prof. T. M. Jasper. Pp. 92. (Urbana, Ill.) 50 cents.

Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich, Heft 3. Festschrift Carl Schröter. Gewidmet von seinen Freunden, Schülern und Kollegen. Im Auftrag des Schröter-Jubiläum-Komitee redigiert von H. Brockmann-Jerosch. Pp. viii+811+28 Tafeln. (Zürich: Rascher und Co.) 30 francs.

Maps showing the Mean Atmospheric Pressure and Wind Direction and Force over the China Sea for each Month of the Year. (Published under the Authority of H.E. the Governor of Hongkong.) Pp. ii+12 maps. (Hongkong: Royal Observatory.) 3 dollars.

Report on the Health of the Army for the Year 1923. (Vol. 59.) Pp. iv+156. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

Report of the Danish Biological Station to the Board of Agriculture. No. 30, 1924: Studies on the Biology of the Oyster (*Ostrea edulis*) in the Limfjord, with Special Reference to the Influence of Temperature on the Sex Change. By R. Spärck. Pp. 84. (Copenhagen: G. E. C. Gad.)

Proceedings of the Royal Society of Edinburgh, Session 1924–1925. Vol. 45, Part 4, No. 29: The Precipitation of Sols by Polyvalent Ions. By Dr. W. W. Taylor. Pp. 323-333. 1*s.* Vol. 45, Part 4, No. 30: Salmon (*Salmo salar*) of the River Moisie (Eastern Canada). By W. J. M. Menzies. Pp. 334-345. 1*s.* 6*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Imperial College of Tropical Agriculture. Prospectus for the Year 1926–27; Principal's Report and Register. Pp. 25. (Trinidad; London: 14 Trinity Square, E.C.3.)

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 9: The Estimation of Aldehyde in Alcoholic Liquors by Means of Schiff's Reagent. By Dr. Kenneth C. Bailey. Pp. 58-70. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d.*

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1924. Pp. vi+80+6 plates. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

Carnegie Institution of Washington. Year Book No. 24, July 1, 1924, to June 30, 1925; with Administrative Reports through December 11, 1925. Pp. xix+46+392. (Washington.)

Věstník Královské České Společnosti Nauk: Třída matematicko-přírodovědecká. (Mémoires de la Société royale des Sciences de Bohême: Classe des Sciences.) Ročník 1924 (Année 1924). Pp. iv+525. (Praze (Prague): Františka Řivnáče.)

Diary of Societies.

SATURDAY, JANUARY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. Balfour: The British Coracle or Skin-covered Boat, and its Affinities.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—P. F. Hope: The Sinking of Monkton Shaft.

INSTITUTE OF METALS (North-East Coast Local Section) (jointly with Institution of British Foundrymen) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.

MONDAY, FEBRUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Edmunds: Pseudo-Hermaphroditism and Hypospadias and their Surgical Treatment.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—G. O. Case: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—G. C. Field: Ancient Philosophy and Modern Science.

ROYAL SOCIETY OF ARTS, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lecture) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Institution of Mechanical Engineers), at 8.—F. H. Carr: The Training of Chemists for Industry.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presidential Address to Students.
ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Dr. F. J. Poynton: The Part taken by Doctors in the Early Days of Aeronautics.

TUESDAY, FEBRUARY 2.

IMPERIAL COLLEGE CHEMICAL SOCIETY (jointly with Royal College of Science Natural History Society and Royal College of Science Physical and Mathematical Society), at 5.—Prof. H. E. Armstrong: Chemical Change in General.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. E. K. Rideal: Surface Action (1).
MANCHESTER GEOLOGICAL AND MINING SOCIETY (at the University, Manchester), at 6.—Sir Stopford Brunton: Mining in Canada with regard to Migration.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—S. S. Cook: High-efficiency Steam Installations for Ship Propulsion.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. V. Clarke: Power Factor and Tariff.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.
INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Section) (at Broadgate Café, Coventry), at 7.15.—J. R. Harnott: Developments in Motor Cycle Design.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—Capt. Rogers: Ships' Cargo Handling Appliances.
RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—R. J. McCallum Tozer: A Gas Tube with Variable Penetrating Power.—M. A. Codd: A New Regulator for a Gas Tube.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Institute of Engineers, Cardiff).—W. J. U. Woolcock: Medicinal Fine Chemicals.

WEDNESDAY, FEBRUARY 3.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Ridley and others: Discussion on Power Production and Transmission.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. J. E. Adams: The Surgery of the Jejunum.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. S. J. Shand: The Alkaline Rocks and Ring-Intrusions of Pilansberg (Transvaal) (Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—J. Hollingworth: The Propagation of Electric Waves.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—Dr. L. H. Lampitt and E. B. Hughes: The Determination of Copper in Vegetables.—Dr. H. E. Cox: Arsenic in Apples.—A. J. Berry:—The Titration of Thallous Salts by Potassium Iodate.—C. H. Wright: The Hot Springs at Nasavusavu.
ROYAL SOCIETY OF ARTS, at 8.—Sir John Russell: Investigations in Agricultural Science at Rothamsted.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—G. Fox-Wilson: The Insect Visitors to Slime-Flux.

THURSDAY, FEBRUARY 4.

ROYAL SOCIETY, at 4.30.—Prof. W. A. Bone and R. Quarendon: Researches on the Chemistry of Coal. Part IV.—G. M. B. Dobson and D. N. Harrison: Measurements of the Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.—Dr. C. Chree: Atmospheric Ozone and Terrestrial Magnetism.—Dr. J. S. Owens: Condensation of Water from the Air upon Hygroscopic Crystals.—*To be read in title only*:—Prof. T. H. Havelock: Wave Resistance: Some Cases of Unsymmetrical Forms.—Dr. H. Jeffreys: On the Formation of Water Waves by Wind.—Prof. G. T. Morgan, W. J. Hickinbottom, and T. V. Barker: Stereoisomeric Diaryl-β-γ-Diamino-N-Butanes.—Prof. G. T. Morgan and G. R. Davies: Antimonial Analogues of the Cacodyl Series.—Prof. G. T. Morgan and V. E. Yarsley: Dimethylstibine Cyanide, an Analogue of Cacodyl Cyanide.
LINNEAN SOCIETY OF LONDON, at 5.—C. C. A. Monro: Polychæta of the *Alert* Expedition;—Conclusion.—Dr. C. C. Hurst: On the Nature and Origin of Species in Rosa.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. L. Myres: Who were the Greeks? (1).
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. V. Clark: Power Factor and Tariff.—E. W. Dorey: Power Factor Improvement.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—C. L. Lawrence: American Aeronautical Engine Practice.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—Dr. A. Parker: The Smokeless Fuel Problem.
INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—W. J. H. Leverton: The Æsthetic Treatment of Concrete.
CHEMICAL SOCIETY, at 8.—F. G. Mann and Sir William J. Pope: (*a*) The Complex Salts of $\beta\beta'\beta''$-triaminotriethylamine with Nickel and Palladium; (*b*) $\gamma\gamma'\gamma''$-Triaminotripropylamine and its Complex Compounds with Nickel.—P. L. Robinson and H. C. Smith: A Comparison of the Atomic Weight of Silicon from Different Sources.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow), T. B. Mackenzie: Modern Steel Works Plant for Boiler and Ship Plates Manufacture.

FRIDAY, FEBRUARY 5.

ROYAL SANITARY INSTITUTE (at Town Hall, Bradford), at 3.—Dr. J. R. Kaye, Dr. Helen M. Gall, Dr. Charlotte A. Douglas, Katherine Gamgee, and others: Discussion on Child Welfare Centres and their Adjuncts.—At 5.—F. Marsden, F. White, and others: Discussion on Town Planning and Improvement Areas.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—R. D. Oldham and Prof. Turner: The Depths of Earthquake Foci in Relation to Distribution of Intensity on the Surface. Sir Gilbert Walker in the chair.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. M. Woodman: Malignant Disease of the Œsophagus.
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—A. Reavell: Fluid Heat Transmission for High Temperatures in Industrial Processes.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—S. L. Eavestaff: Thoughts which occur to me.
PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—F. A. Ruddock: Photomicrography applied to Metallurgy.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea Technical College), at 7.30.—C. A. Seyler: Micro-structure of Coal.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Question and Discussion Evening.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—E. Clarke: Launching.
GEOLOGISTS' ASSOCIATION (at University College) (Annual General Meeting), at 8.—H. Dewey: Studies in Danish Geology (Presidential Address).
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. Gordon: Shakespeare's English.

SATURDAY, FEBRUARY 6.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Annual General Meeting) (at St. Paul's Girls' School), at 10.30 A.M.—Educational Films, chiefly Scientific, shown by the Visual Education Society.—At 2.30.—Miss Coward: The Teaching of Hygiene in Schools; Short Papers on the same subject.
SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with Institute of Chemistry and Wales and Monmouthshire Junior Gas Association) (at University College, Singleton Park, Swansea), at 2.30.—C. A. Seyler: The Microscopy of Coal.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: The Triad and the Perfect Fourth (1).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Miss L. E. Cheesman: Insect Collecting in the Society Islands.

PUBLIC LECTURES.

SATURDAY, JANUARY 30.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Glimpses of Indian Places and Peoples.

MONDAY, FEBRUARY 1.

UNIVERSITY COLLEGE, at 4.—Prof. A. V. Hill: The Physiology of Muscle. (Succeeding Lectures on February 8, 15, 22, March 1, 8.)—At 5.15.—Dr. R. W. Lunt: The Chemistry of Ionisation by Collision. (Succeeding Lectures on February 8, 15, 22, March 1, 8.)—At 5.30.—Dr. A. S. Parkes: The Physiology of Reproduction. (Succeeding Lectures on February 8, 15, 22.)—At 5.30.—Prof. E. De Martonne: Two French Geographical Regions: (1) Brittany; (2) The "Causses" of Southern France. (Succeeding Lecture on February 2.)
KING'S COLLEGE, at 5.30.—Dr. F. A. P. Aveling: The Human Will (3). Post-Renaissance Views.

TUESDAY, FEBRUARY 2.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: Philosophy and History (1). History in the Absolutist Philosophy.
UNIVERSITY COLLEGE, at 5.30.—Miss M. A. Murray: Primitive Cults in Ancient Egypt.

WEDNESDAY, FEBRUARY 3.

UNIVERSITY COLLEGE, at 5.30.—B. M. Headicar: The London School of Economics Library, its Work and Methods.

THURSDAY, FEBRUARY 4.

UNIVERSITY COLLEGE, at 4.30.—Prof. E. G. Gardner: The Florentine Academies in the Renaissance.
KING'S COLLEGE, at 5.—Dr. J. A. Hewitt: Metabolism of Carbohydrate and Fat. (Succeeding Lectures on February 11, 18, 25, March 4, 11.)

SATURDAY, FEBRUARY 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Quest for Gold and Pearls in Ancient Times.

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