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The Metric System and World Trade.

A SHORT time ago (March 29) Dr. C. E. Guillaume contributed to the Paris Academy of Sciences a paper on the obligatory adoption of the metric system in Japan. The recent Japanese law making the metric system compulsory after a fixed period will no doubt have considerable effect towards rendering the system familiar in trade in the Far East, where its use is already facultative in some countries. Before arriving at this decision the Japanese Government dispatched a Commission of Inquiry to the principal trading centres of the world, so that the present law represents the outcome of prolonged and mature judgment, and as such supplies very satisfactory evidence in support of the international claims of the metric system. The values of the old units of Japan have for many years been defined in terms of the metre and the kilogram, and, owing to this fact and to the issue of regulations on the subject, the trading community has gradually become accustomed to metric weights and measures. Dr. Guillaume expects that in a few years the only weights and measures permissible in eastern Asia will be those of the metric system. The enormous strides made by this system in the Far East cannot be without effect in the United States, where in the past one of the principal arguments against it was that British weights and measures were tacitly recognised in China, Japan, and Siam. It appears probable, therefore, that before long advocates of the metric system will be able to turn this line of reasoning against their opponents.

By its recent decision Japan has once more shown its readiness to change its customs in order to adapt itself to changing needs. Its statesmen have recognised that the metric system is the only system of service for international trade, and have, therefore, decided that their country shall not be handicapped by traditional use and human inertia from adopting new standards of measurement. We have no patience with any other policy. Whether a principle is sound or not may be discussed, and whether its adoption is expedient or not may also be a matter of opinion; but to suggest that a particular policy should not be followed merely because there are many difficulties in the way is to manifest a state of mind which we fail to understand. The first thing to decide in individual or national life is whether an action is right; and once having arrived at an affirmative conclusion, difficulties are nothing but obstacles to be surmounted boldly or swept aside ruthlessly from the path of progress.

This we conceive to be the true scientific spirit, and by the use of it Japan has won the high position which she now occupies among the nations of the world. We must confess, however, that in the matter of the adoption of the metric system there are few signs that like action will readily be taken in our own country. It is perhaps not surprising that Lord Balfour of Burleigh's Committee on Commercial and Industrial Policy after the War should have reported that it was not desirable to make a compulsory change in our system of weights and measures; but we expected something different from a committee appointed by the Conjoint Board of Scientific Societies. The report of this committee was dealt with in our issue of October 7 last, p. 169, and the only satisfactory thing about it from our point of view is that the Conjoint Board declined to adopt the report, which was, therefore, published on the authority of the committee alone.

In justice to the committee it must be said that the inquiry with which it was entrusted was solely that of the compulsory adoption or otherwise of the metric system in the United Kingdom, and not the advantages or disadvantages of the system in comparison with the British system of weights and measures, or its scientific aspects in general. Some of these subjects were, however, discussed—not altogether impartially—by the committee in its report; and the conclusion

reached was "that the British system of units of weights and measures be retained in general use in the United Kingdom." Interesting suggestions were made as to the decimalisation of our system and the abolition of several unnecessary units; but even if this were accomplished the result would still be that British manufacturers would have to continue to employ two systems—one for home trade, the other for trade with the increasing number of countries overseas in which the metric system is commonly used.

Neither Lord Balfour's Committee nor that of the Conjoint Board gave adequate attention to the value of official encouragement as a *via media* between legal permission and legal compulsion. The Act of 1897 made the use of the metric system permissive, and official adoption of the system now would pave the way to legal compulsion at a later date.

The many reports of our Consuls and representatives abroad have shown in the most convincing way that the practice of those British manufacturers who use only British weights and measures in their catalogues and price lists intended for other countries has a prejudicial effect on the extension of our foreign trade, particularly in countries where the metric system is used exclusively. In the textile trades British measures are no doubt widely recognised; but there is not the slightest reason for hope that their usage can be made international by common consent. The only possible international system is the metric system, and as a nation we cannot afford permanently to remain outside it. When the metric carat was legalised for use in trade in 1914, its adoption by dealers in diamonds and precious stones was practically complete in a few weeks, though they were previously opposed to the change. The weights and measures now given in the British Pharmacopœia are all in the metric system, and Imperial standards are entirely omitted. The dual system formerly used was found to be a constant source of trouble, and in 1914 it was abandoned in favour of the metric system alone. In mining statistics the metric ton is now a common standard, and in many engineering and ordnance machines and structures metric measures are now used almost as frequently as British. It cannot be said that our system of weights and measures is extending to other nations in the same way. Nothing that we could do would make the system international, so that what we have to do is to choose between a system which has custom alone to commend it, and must be limited in its use and one which extends over the whole world and becomes more important industrially and commercially every year.

The adoption of the metric system by the United States and the United Kingdom is, indeed, inevitable, and adherence to the Imperial system is an obstacle to world commerce. We shall have to abandon the system sooner or later, and it would not be so difficult to adjust ourselves to the new standards now as it is to adapt ourselves to other conditions of reconstruction brought about by the war. The Colonies have frequently expressed their desire to adopt the system whenever the United Kingdom does so; all our European Allies, and practically half the population of the world, use it, and we cannot avoid doing so eventually. The only two important countries now outside the system are the United States and the United Kingdom, and when either of these enters it the other must follow.

During the war we, and the United States also, were forced to use metric measures in order to secure effective co-ordination between us and our Allies in military maps, range finding, firing data, and ordnance generally, and in the uniform standardisation of motors, aeroplane parts, and other machines and accessories. The result is that millions of men are now familiar with metric units, and would experience little difficulty in adjusting themselves to the change which the introduction of the metric system would involve. Every pupil in every secondary school in this country is made acquainted with the system, and in scientific work its use is universal. "The present chaos of English weights and measures," reported Sir J. J. Thomson's Committee on the position of natural science in the educational system of Great Britain, "causes waste of time and confusion of thought, and these are strong educational reasons for the adoption of the metric system."

The truth is that we have not a uniform system of weights and measures, but a medley of units and standards which differ in different industries and often vary in a single industry. In agriculture a bushel of wheat is defined in official statistics as having a weight of 62 lb.; by the Corn Returns Act it weighs 60 lb., and by the Grain Prices Order 63 lb. Bushels of barley and oats show like variations in weight both officially and according to frequent practice. To secure

uniformity in the weights and measures used in the sale of corn and other crops, the Corn Sales Bill is now being considered by a Committee of the House of Commons; but as the standard proposed is one of 112 lb., while the whole of the futures market is based on the decimal system, the Bill can be nothing more than a makeshift measure. In the textile industries, from which comes the chief opposition to the use of metric measures, the standards of measurement vary greatly in different centres, and there is no common relationship between them. British and American measures with the same denomination, such as the pound, yard, gallon, and bushel, also differ in quantity in the two countries. The advantages of a uniform system—a common language—from the point of view of world service are obvious, and the jealous attitude of conservative corporations towards it represents, not the spirit of progress, but rather that of obscurantism.

The fact that local and trade usage sanctions such a variety of weights and measures as that now existing in this country and in the United States is in itself sufficient to justify a movement towards reasonable uniformity. There is an official British system of weights and measures, but when trade transactions are concerned its standards are often varied to suit industrial convenience or local custom. A proposal that the British standards should be made compulsory in all transactions, and that no departures from them should be recognised, would evoke quite as much opposition as is now offered by certain industries to the introduction of the metric system. No one supposes that by making the metric system compulsory after a period of years the people as a whole would think in terms of metric units. Local denominations of fractions and multiples of such units are commonly used in all countries where the metric system has been adopted, but they do not interfere in the slightest degree with the larger transactions of trade and commerce.

If the Government adopted the metric system as the sole legal system in all its Departments, and announced that after a particular date all specifications for its work would have to be expressed in terms of that system, a great step would be taken towards its general use. This course and the publication of all official trade statistics in metric terms would lead to similar action by municipalities, railways, and other corporations, and promote the voluntary adoption of metric standards by the trading community generally.

Lamarckism Unashamed.

Initiative in Evolution. By Dr. W. Kidd. Pp. x+262. (London: H. F. and G. Witherby, 1920.) 15*s.* net.

FOR more than twenty years Dr. Walter Kidd has interested himself in the arrangement of the mammalian hair, and pondered over its significance, especially in relation to theories of evolution. He has shown that definite patterns due to the diverse lie of the hair are of common occurrence, that they are subject to change, and that they are hypothetically interpretable on Neo-Lamarckian lines. Whether one agrees with his interpretations or not, one must thank him for a very enjoyable book, written with whimsical humour and with a delightful urbanity in controversy. One admires also the candour with which Dr. Kidd states and seeks to dispose of some serious criticisms brought against his position as expressed in previous books.

A study of the lie of the hair on a cow shows great definiteness; thus it slopes first backwards and then forwards on the neck; behind a whorl over the shoulders it slopes backwards again; along the middle line of the upper part of the tail there is a streak of hairs at right angles.

"Arrangements of its hair so audacious as these need explanation, and it is found in the mode of life of the cow. So large a part of its daily life is spent in the business of grazing with her muzzle close to the ground, during which the neck of the animal is constantly stretched downwards from the back at the level of the shoulders, that the skin, which is very loose in this and most other portions of its body, is dragged upon to allow of the extreme flexion of its neck. This traction is for all this time acting against the normal or backward slope of the hairs, and has given rise to this victory of a new force through a thousand generations. It is equally clear that a mechanical explanation of the line of erect hairs on the first nine or twelve inches of the tail is forthcoming, for one has only to watch a cow standing on a hot day, undergoing her torment of flies, to see it writ large. . . . It is hardly necessary to point out how the underlying muscles would drag upon the skin of the tail over them and gradually reverse more or less the 'lie' of the hairs."

Similar interpretations, often very ingenious, abound in the pages of Dr. Kidd's book. There is an unusual pattern of hairs on man's back; it is to be correlated with his ancestors' habit of sitting with their backs against the side of the cave, or sleeping with their heads raised on some sort of pillow. From between the eyes of a cat the hair on the broad snout slopes downwards, but on a dog's snout it slopes upwards; this is put down to the fact that the dog rubs his head on the

sward from the front of the snout upwards, while the cat dresses her snout downwards with her paw. We should think this was a *hysteron proteron*—the cart before the horse. The dog has on his chest a reversed area of hair—spreading out on each side. "When lying with his head supported on his paws the lower part of his chest is closely applied to the upper or flexor surface of the fore legs, and the long-continued pressure of the latter against the downward or normal streams of hair on the chest leads to its slope being reversed." The downward slope of the shaggy hairs of the two-toed sloth, that spends so much of its time upside down below the branches, is to be attributed to the action of gravity upon the long hairs. We wonder that the author does not allude to the downward pull which the coating of green Algæ on the hairs must involve!

The factors recognised by Dr. Kidd in the formation of hair-patterns are four: friction, pressure, gravity, and underlying muscular traction. His thesis is that changes in the conditions of life —*e.g.* in modes of locomotion and in attitudes of rest—have directly brought about modifications in the lie of the hair, and that these modifications have been cumulatively entailed on the race.

"Initiative in animal evolution comes by stimulation, excitation, and response in new conditions, and is followed by repetition of these phenomena until they result in structural modifications, transmitted and directed by selection and the laws of genetics—a series of events which agree with Neo-Lamarckian principles."

Now it is familiarly easy for Lamarckians to interpret structural peculiarities as the outcome of transmitted exogenous modifications (the direct somatic results of peculiarities in function, habit, nutrition, and environment), and Dr. Kidd is much too thoughtful an investigator to be content with mere interpretation. He brings forward evidence to show that the lie of the hair can be modified in the individual; he also brings forward some evidence to show that parental modifications may reappear in the offspring. Speaking frankly, we do not think the evidence is strong, but it is progress to have any evidence at all.

As regards individual modifications of the hair-pattern, reference is made to the way in which the peculiar functioning of the muscles in the vicinity of the human eyebrow alters its shape and character.

"It is shown by numerous examples in the human eyebrow that the muscles underneath the hairs which are embedded in the true skin for a tangible depth, *do* play havoc with the normal arrangement of hair, as the conflict proceeds, the resultant 'pull' being actually engraved, signed and sealed by physiological wrinkles of the forehead and face."

It may be so, but one must tread warily. There are individual idiosyncrasies in the eyebrows hinted at very early in life, long before the time of wrinkling, which become emphasised when the eyebrow hairs grow longer, as they so often do in later life. First catch your modification.

A little more cogent, it seems to us, is the chapter on the modifications in the hair-patterns of horses, modifications which can be traced to peculiarities of harness. Yet here again there is need for scepticism. One has to be sure that the peculiarities observed are not constitutional variations, quite independent of harness; and here one must go back in Dr. Kidd's book to the excellent treatment of the whorls, featherings, and crests that frequently occur on the horse's neck, most of which cannot, without great difficulty, be regarded as modifications. Moreover, one has to remember that in a hard-worked horse there may be a coercive reversal of the moist hair, which never gets a chance to right itself, and is not, therefore, a true modification which persists after the inducing factors have ceased to operate. As to the ten foals showing a reversed area or pattern on the under surface of their necks similar to that which their mothers showed, we wish to be sure that the maternal reversal was due to the collar. But of the value of collecting cases like this, even if they do not convince sceptics, there can be no doubt, and Dr. Kidd will be thanked by all biologists.

Dr. Kidd supports his case with facts relating to the formation of new bursæ under the stress of mechanical forces and to Pavlov's experimental production of new reflexes in the life of the individual, but he stakes his argument on the lie of the hair. His general position is that initiatives or new departures in evolution are direct answers to peculiarities in nurture (activity, rest, food, and environment), and that these answers are transmissible in a representative way which becomes cumulative, unless, indeed, selection intervenes. He coins the word "plasto-diēthēsis," combining the metaphors of mould and sieve; the organism is moulded in some new way by peculiarities in function and environment, and the moulded organisms are sifted. "So the banns between Lamarck and Darwin are published, not for the first time of asking, and who shall say that there is cause or just impediment why these two should not be joined in holy matrimony?"

We suspect that the lie of the hair is fixedly determined by the slope of the hair follicle beneath the surface of the skin, and that this slope, though

adjustable temporarily by contraction of the smooth muscles associated with the follicle, is determined by old-established skin conditions—*e.g.* of muscularity, blood supply, and innervation. We should compare the general lie of the hair to the pterylosis in birds, and also, in kind, to the way in which the hairs of different mammalian types occur in distinctive or specific little groups, the members often differing in size. It may be that the vertically upstanding hair of the mole represents a primitive mammalian condition without any lie at all. Whether this be so or not, the lie of the hair is variable, as the study of the horse's neck suffices to show. These variations, comparable to variations in other skin-features—*e.g.* papillary ridges—may be the somatic expression of germinal variations, and it may also be that they are correlated with larger variations of a more obviously utilitarian character. We need not think of them as "anyhow" changes, but rather as more or less consistent with a harmonious viable constitution previously established. In any case, they are the cards put into the hands of the full-grown mammal—cards which he has to play, the result being the sifting out and survival of the "lies" most conformable with the creature's habits. But we cannot prove our Neo-Darwinian theory any more than Dr. Kidd has proved his Neo-Lamarckian one. Some may say not so much. J. A. T.

Dyes and Dyeing.

Application of Dyestuffs to Textiles, Paper, Leather, and other Materials. By Dr. J. Merritt Matthews. Pp. xvi+768. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 57*s.* 6*d.* net.

THE author introduces his subject with "Craft Dyeing," followed by a short history of dyeing. In discussing tie-dyeing (knot-dyeing), batik and stencil work—some of the earliest methods of producing coloured patterns on fabrics—he makes the rather interesting suggestion that craft dyeing should be encouraged, as the field for it in America is a broad one, because in it "we have the possibility of reaching into realms of colour art that is not present in ordinary trade dyeing." As in the author's former work, "The Laboratory Manual of Dyeing and Textile Chemistry," each chapter is followed by instructions for carrying out experiments relating to the processes described. These should be of considerable assistance to students in technical colleges.

Chap. ii. deals with the scouring of textile fibres. In this an illustration is given of what purports to be an "Open Kier for Treating Cloth with Caustic (H. W. Butterworth and Sons Co.)," which, however, is not a kier, but the preparing and batching arrangement employed in impregnating the fabric prior to boiling in the open-width Jackson kier. The kier proper has been omitted. On pp. 136–37 the author describes the preparation of sodium hypochlorite by passing chlorine gas into caustic soda or soda ash. Bleachers in this country will be interested to hear that "this method of bleaching has come into very extensive use in the United States."

Under "Representative Acid Dyes" (chap. viii.), a "Nomenclature of Dyestuffs" is given. We agree with the author that as regards dyestuffs his task in bringing the information up to date must have been one of considerable difficulty. He is to be congratulated upon this part of the work, and we think he has acted wisely in that he "has deemed it advisable to retain the names and the dyestuffs that were well known before the war, and which could be easily and intelligently recognised in the industry all over the world." The alphabetical list of trade names of the various groups of dyestuffs, in which the class to which each belongs and the manufacturer are given, and the list of the principal dyestuff manufacturers, will be found very useful indeed. A very complete list of all the principal dyestuffs, arranged according to shade, is also given.

In the following chapters the stripping of colours, the testing of the fastness of dyes, and the application of the various artificial and natural dyestuffs are discussed. This is followed by a brief description of the mineral colours, and in the next chapter (which should have been numbered xxiii.) by "Dyeing of Fabrics containing Mixed Fibres." In this some very useful tables showing the affinity of a number of dyestuffs for different fibres are given. The dyeing of other fibres, including linen, jute, and artificial silk, is referred to very briefly. Cellulose acetate silk is not mentioned.

The theory of dyeing is outlined in chap. xxv. It is to be regretted that in this chapter only three references to the literature are given. The name of one of the investigators mentioned should read "Vignon."

The author has compiled an extensive bibliography. The value of this would have been considerably enhanced if references to it had been given in the text. This is an unfortunate omission which it is hoped the author will rectify in a new edition of the work.

The volume contains 303 illustrations of machinery in use in the various operations, but few of these, comparatively speaking, are of American origin. Some of the illustrations which are given in diagrammatical sections are of value to the student, whilst many, which are simply pictures, convey little or no information as regards working details. In a few cases only are the machines fully described in the text.

Forty-one pages are devoted to the dyeing of about twenty-five different materials, including leather, paper, furs, feathers, foodstuffs, etc. In this the author has made an attempt to cover a very wide field indeed, but, as stated in the preface, he has been able to give only "a brief survey of these interesting fields." Some of the information given should, nevertheless, be of value to workers.

In a short review such as this it is unfortunately impossible to discuss the contents of the volume more fully. The book certainly deserves the attention of those interested in the dyeing of textiles and other materials. The amount of information which it contains is very considerable, and it is, therefore, safe to assume that at least some parts of its contents will appeal to every reader. J. HUEBNER.

Time and Space.

The Absolute Relations of Time and Space. By Dr. A. A. Robb. Pp. ix+80. (Cambridge: At the University Press, 1921.) 5*s.* net.

IN 1914 Dr. Robb published a work entitled "A Theory of Time and Space." Bearing in mind the circumstances of that year, it is not surprising to find that the book did not attract a notice commensurate either with the intrinsic importance of the subject or with the novelty of the views propounded in it. The short work bearing the above title is introductory to the larger work, and contains a concise statement of the main results embodied in it. The treatment is very different from that of Einstein. In Einstein's theory the emphasis is laid exclusively on the idea of the "relativity" of experience. Dr. Robb, on the other hand, postulates as the basis of his theory an *absolute* relation—namely, the relation of "before and after." Not only does this relation serve as a physical basis; it is also the foundation on which he builds a goodly structure—his purely geometrical theory of time, of which the theory of space forms a part.

In the first section, devoted to preliminary considerations, the author shows by simple illustrations the difficulty of giving precise meanings to apparently simple concepts such as the equality of lengths, and makes clear the close interdependence of time and spatial measurement. The keystone of his work is to be found in his treatment of the problem of identifying the same instant of time at two distinct points of space. In Einstein's theory each observer carries his own local time, and events which are simultaneous to one observer are not necessarily so when compared by the local time of another. Rightly dissatisfied with this view, the author adopts the bold point of view contained in the statement that there is no identity of instants at different places at all. In his own words, "the present instant, properly speaking, does not extend beyond here." It follows, then, that the complete specification of an instant of time requires the use of four co-ordinates (x, y, z, t).

The author then develops, by means of a system of twenty-one postulates, his four-dimensional geometry of time, and this development is characterised not only by a high degree of originality—particularly evinced in his novel and striking concept of conical order—but also by much skill and insight. Elements of time forming a system characterised by conical order, the spatial aspect, explicitly introduced in postulate v., becomes a direct consequence of this order. Analytically, after co-ordinates have been introduced, the theory leads to Einstein's restricted relativity. The work is a most valuable and original contribution to a very abstruse and difficult subject. More satisfactorily grounded than Einstein's theory, its far-reaching results merit the closest study, not only from the physicist, but also from the geometer. To the latter, indeed, it makes a strong appeal, since, as the author points out, the simple asymmetric relation of "before and after" appears to have important advantages over the concept of "linearly between" which has hitherto been mainly used as a basis for systems of geometry. J. F. T.

Our Bookshelf.

L'Alimentation et L'Elevage Rationnels du Bétail. (Opinions du Prof. A. Mallèvre.) By J. E. Lucas. Pp. 466+4. (Paris: Librairie Lefrançois, 1920.) 18 francs.

THE lives of most men of science are divided between teaching and research; he is indeed fortunate who can harmonise the duties. The late Prof. Alfred Mallèvre, whose premature death in 1916 deprived France of a brilliant teacher and keen investigator, seems often to have regretted that his professorial duties left but little leisure for research, and it is sad to read, in the eloquent notice of his career by M. Georges Wery pre-

fixed to the volume before us, that the Agronomic Institute at Joinville-le-Pont obtained suitable laboratory accommodation only when Mallèvre was nearing the end. His devotion to duty did, however, reap the reward of enthusiastic pupils who have introduced scientific methods into fields which they might not otherwise have reached; M. Wery specially refers to the fruitful collaboration between Mallèvre and M. J. E. Lucas, whose notes of his professor's lectures have been published. The book is indeed a clearly and practically written treatise on the physiology of animal nutrition suitable for any intelligent student in a school of agriculture.

The first eight chapters deal with the general principles of the subject, and cover ground fairly familiar to the student of general animal physiology. Mallèvre was a definite adherent of the isodynamic school, and subjected Chauveau's experiments to searching criticism.

Chaps. ix. and x. are of particular interest to the farmer, and Mallèvre's tables, based upon Kellner's methods, should be of great use.

In the chapters which follow, the effects of exercise, environment, and heredity upon farm animals are considered, and the work concludes with a short, but clear, account of methods available for the protection of stock against infectious diseases.

Had the author himself lived to publish a text-book, he would probably have devoted rather more space to recent work upon accessory food substances, and perhaps have made more use of American work on calorimetry. The chapter on heredity also needs some revision. These are, however, minor points; taken as a whole, the book is well adapted to the purpose for which it was designed.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-making Alloys, their Ores and Graphites. By C. M. Johnson. Third edition, revised and enlarged. Pp. xi+552. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 36*s.* net.

THE number of elements employed in the manufacture of alloy steels appears to be ever increasing, and to it there have been added, during the last few years, cobalt, uranium, zirconium, and cerium. Accordingly, a new edition of the above work, embodying the latest American practice in the analysis of such steels and of the alloys used in their production, is very welcome.

Amongst other features which the one hundred pages of new matter contain are: A new and original method for the determination of sulphur; the partial separation of iron from such elements as vanadium, uranium, zirconium, and aluminium by a process which dispenses with the "ether separation"; important modifications of older processes; illustrated descriptions of new forms of laboratory appliances; and a chapter on micrographic analysis.

Repetition of unnecessary details and more than a few obvious mistakes betray a somewhat hasty preparation, and, moreover, the arrangement of the whole subject-matter leaves much to be desired, though the last defect is remedied to some extent by a good index and numerous cross-references. Steelworks' chemists, at any rate, will doubtless overlook deficiencies of this nature in a book which emanates from such a trustworthy, experienced, and original worker as its author.

Stones and Quarries. By J. Allen Howe. (Pitman's Common Commodities and Industries.) Pp. x+137. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s.* net.

MR. HOWE is specially qualified among geologists by his economic studies at the Jermyn Street museum for writing a book on stones and quarries that will interest the general reader. Such readers constitute the bulk of intelligent persons, who prefer to understand what they meet with on their travels and are not content with mere wonder at the wealth of the earth and the ingenuity shown in its exploitation. Mr. Howe begins by showing the æsthetic feeling for cut stones among the Egyptians 7000 years ago, and the gradual development of carved and polished work by race after race, down to the cathedral builders of western Europe. "Porphyry," by the by, was practically unknown to the Egyptians, and one would scarcely gather, from the associations ascribed to it on p. 3, that the Taj Mahal was a work of the seventeenth century. Two felspar formulæ on p. 10 have escaped proof-correction, but these are only trifling criticisms. The numerous views of quarries in active operation, and the description of the machines used, open up a new and healthy field before the professional petrologist. The use of columnar basalt for road-setts in Italy and for the retaining walls of canals in Holland might be added to Mr. Howe's instances of the applications of rock-structure to human needs. G. A. J. C.

The Chemistry of Synthetic Drugs. By Dr. Percy May. Third edition, revised. Pp. xv+248. (London: Longmans, Green, and Co., 1921.) 12*s.* 6*d.* net.

VERY few changes have been made in this work since the first edition, reviewed in NATURE for September 21, 1911, was published. The third edition, which is now issued, follows closely on the heels of the second, and, indeed, the publication of information gained during the war in the chemistry of poisons, irritants, etc., appears to constitute the greater part of the alterations which have been made. The poisonous nature of most poly-nitro-compounds has been completely established, and new facts relating to other toxic substances, such as phosgene and mustard gas, which were used by the belligerents are recorded. The volume will no doubt be found extremely useful by those engaged in the manufacture of synthetic drugs.

Letters to the Editor.

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

Earth-worms, Mud-worms, and Water-worms.

I GATHER from various correspondents that the word "earth-worm" requires some elucidation if we are to avoid misconception. I venture to submit the following statement. The Chætopoda, or bristle-footed worms—often called the "Annelids"—form one of the three large branches of the phylum Appendiculata. The Arthropoda (=Gnathopoda) and the Rotifera are its two other branches. The Chætopoda are divisible into the class "Polychæta" (all marine) and the class "Oligochæta"—containing very few marine forms, and inhabiting either the slime and mud of fresh-water pools and streams, or the loose, damp "humus" or "earth" of the land-surface.

I think that the opinion expressed by Mr. Coste (in his valuable letter in NATURE of May 19, p. 360), to the effect that "the moist surface" of worms inhabiting the soil "must, when underground, frequently or usually be in contact with other moist surfaces, so that the worm is, in effect, partly immersed in water," involves a mistake as to the condition of the earth thus inhabited and the size of the burrow made by the worm. The earth inhabited by earth-worms is *not* slime or mud, and does not fit closely to the worm's body as would a semi-liquid mud or soft clay. It is, on the contrary, a loose aggregation—the solid particles of which are largely separated by atmospheric air—and the worm's body does not fit tightly to the walls of its burrow, although a mucous exudation from the worm's surface is often deposited on those walls. An earth-worm in movement is continually changing its dimensions—elongating and becoming narrow, shortening and becoming wider. Hence there is no "immersion" of the worm's body in liquid or semi-liquid material. On the contrary, air has continual access to the worm's surface through the *porous* soil; and the change in its diameter and its movements must cause the movement of the air in the space between the worm's body and the wall of its burrow. It seems to be necessary to bear in mind the distinctive physical features of the earth or surface soil in which the earth-worms make their burrows—as contrasted with either the water or the mud—practically a liquid—in which other Oligochæta pass their lives.

The Oligochæta are divided into four orders, namely, the Naidiformia, the Sænuridiformia, the Lumbriciformia, and the Hirudiniformia (or leeches). The first of these is a very distinct group inhabiting fresh-waters (only two British species are marine). They are much smaller in size than the others, and are characterised by young forms which reproduce abundantly by bud-fission, and are succeeded by a distinct adult sexual form. The Sænuridiformia and the Lumbriciformia are closely allied—the former being as a rule smaller, more elongate, and more agile in movement than the latter, and less familiar to the inexpert observer. They inhabit fresh-waters (a few only are marine) and the mud or slime of fresh-water pools of brackish estuaries and of sluggish streams, whilst the Lumbriciformia are large worms with opaque, thick body-wall, which forcibly burrow in loose, air-holding earth, and have, as a rule, a close resemblance to our common earth-worm in shape, colour, and habits. The larger Sænuridiformia, such as Lumbriculus and Phreoryctes, have the brown-red colouring of earth-worms, and, although differing in shape and movement from Lumbriciformia, are liable to be mistaken for young earth-worms when appearing, as they sometimes do in great number, in the reservoirs and mains of water-supplying companies.

The Lumbriciformia comprise a great number of genera distinguished by peculiarities of their reproductive apparatus, their renal organs (nephridia), and the gizzards and other parts of the digestive canal. They have as a rule a specially rich supply of blood-vessels to the integument which serves as a respiratory organ. This special blood supply is not present in the Sænuridiformia, which have, however, well-developed, deeper-lying vascular trunks holding hæmoglobinous fluid.

The word "earth-worm" is often applied to the whole group of Lumbriciformia, which are contrasted as "Terricola" with the Sænuridiformia, for which the term "Limicola," or "mud-dwellers," is used. There are good reasons, however, for limiting the word "earth-worm" to the common English earth-worm, *Lumbricus terrestris*, and the few closely allied species of Lumbricus. Those reasons come to our notice when we are considering the possible drowning of the common earth-worm and the respiratory conditions connected with that mishap. They are, first, that a whole family of Sænuridiform worms is known—the Enchytræidæ—which are *not* water-dwellers or mud-dwellers (Limicola), but live in humus and amongst dead leaves, and are, in fact, just as much "Terricola" as are the commoner Lumbriciformia. And, secondly, there are at least two genera classed with the Lumbriciformia which live, *not* in the earth, but in open water. One of these is the *Criodrilus lacuum* (occasionally found in England, but common in Central Europe), which has the appearance, size, and inner structure of the Lumbriciformia—and, indeed, is a close ally of Lumbricus; and the other is the *Alma nilotica* or *Digitibranchus niloticus*, which not only lives entirely in the water, but is also provided with a series of filamentous, naked branchiæ containing a blood-red vascular fluid. I am not able to state whether Criodrilus has or has not a tegumentary blood supply. It has not, I think, been studied from this point of view. There is no full account (so far as I can ascertain) of the structure of *Alma nilotica*, nor have illustrations of its anatomy been published, though systematists have given brief accounts of this and allied species.

I think, then, that it is clear that we must not extend the implications of the word "earth-worm" when discussing details of structure and physiological adaptation beyond the particular species which has been the actual subject of study. In writing here of the drowning of earth-worms I have intended my statements to apply only to the common British earth-worms called *Lumbricus terrestris*. Probably they are true of many other Lumbriciformia, but that is only a supposition which must be tested and must not be held as fact until proved by further examination to be so. E. RAY LANKESTER.

P.S.—I find that Vejdowski has described a rich network of capillary blood-vessels in the integument of Criodrilus (a Lumbriciform), and that in *Limnodrilus Hoffmeisteri* (a Sænuridiform) he has found capillaries in small groups of four, ending blindly in the epidermic cell-layer. Such capillaries in the integument are, he says, absent, as a rule, from all Oligochæta except the Lumbriciformia. E. R. L.

Biological Terminology.

I THINK Dr. Bather (NATURE, May 5, p. 301) and I may be using our words with unlike meanings, but he raises an important point. To use my own meanings: we describe when we say what a thing is like; we interpret when we account for it. Both these processes imply classification (*i.e.* identification); both are necessary in science; one is not superior or inferior to the other; but they are different. In description we classify facts and objects according to co-existences and resemblances. Thus, when we term a man a mammalian vertebrate we say, in effect, that in him mammæ and vertebræ co-exist, and that therein he resembles other animals. Is not all systematic zoology and botany founded on this kind of classification, a beautiful example of which may be found in the address of any letter sent by post—addressed to a man with a certain name, in a certain house, in a certain street, and so on? On the other hand, when we interpret we explain, we link cause with effect, we formulate suppositions, hypotheses, theories, we trace the connection between antecedents and consequents, we try to understand. Thus we class together such unlike things as the fall of apples, the rise of tides, the swing of the pendulum, and the motions of the planets by saying that they furnish instances of gravitation; we account for teeth and mental faculties by attributing their evolution to natural selection; we identify the blacksmith's muscles, mathematical and golfing skill, and acquired immunity against disease as results of functional activity. From the nature of the case there is little or nothing of this sort of thing in systematic zoology and botany.

Description and interpretation are the warp and the woof of science. The former must always precede the latter, for we cannot account for things until we know what they are like. Some sciences (*e.g.* mathematics and physics) are based on few facts. Thus all the facts on which geometry is founded consist of its axioms and some of its definitions. Necessarily, therefore, this science quickly passed in its evolution from description to interpretation, and its students in their mental development quickly tread the same path. Their main training is in interpretation. They have little knowledge of facts, but great skill in a particular department of thought. Other sciences (*e.g.* zoology and botany) deal with an enormous number of facts; ages must pass before they are at all adequately described, and every student must spend years in acquiring them. His main training, therefore, must necessarily be in description. He acquires a vast knowledge of facts, and, therefore, since he knows what to look for, becomes a trained observer. A mathematician may be an excellent observer, but this skill does not necessarily flow from his specific training. Indeed, it is remarkable within what narrow limits his skill may avail him—just as training in a game (*e.g.* golf) may develop the student's skill only in that particular game. Similarly, though any zoologist or botanist may be a skilful interpreter, skill of this kind does not necessarily flow from his specific studies. This is all that I meant by the statement to which Dr. Bather takes exception.

Man is the educable animal, but he is also the forgetting animal. The things he particularly tends to forget are facts. The things he tends to retain are mental habits, among which are dexterities in thinking and doing. These dexterities, learned slowly and with toil, are even more slowly lost—as in the case of the mathematician and the cricketer. As a schoolboy I received some training in mathematics; to-day the mathematical books in my library are nearly useless to me. Some part of them is at my fingers' ends; the rest I cannot understand. As a medical student I had to cram for examinations what seemed an enormous number of facts about botany and zoology. Almost all that is lost, but I can recapture any of them by reference to my books. Evidently it is sometimes better to teach good mental habits than to impart mere knowledge. No attempt was made to account for the facts of natural history to me (to train me in interpretation), but, fortunately for my future pleasure and interest in life, I had antecedently read Darwin. I doubt whether any of my contemporaries were as lucky. I do not know whether teaching has improved since my day; but this I do know, that while the facts of interpretative biology are abundant, its hypotheses innumerable (more than two hundred explanations of sex alone have been formulated), and its controversies unending, it has, unlike physics, for instance, next to no established truth. I know also that its terminology is so loose that it is often used with no meanings or with contradictory meanings, that its hostile sects ignore one another's evidence, and that all sects unite in ignoring evidence derived from other sciences. There is, in fact, no general use of crucial testing, which is the only means by which people of divided opinions can reach a common platform and hypotheses be examined in the light of all the evidence. I know besides that it is harder to interest biologists in the big question of biology, or in any questions not purely sectarian, than it is to interest anyone else.

This question of crucial testing is important. Probably it lies at the root of most of the troubles of interpretative biology. Given crucial testing, not only would all the relevant facts be brought into court and hypotheses be proved and, if correct, established, but also the necessity for a correct terminology would become clear. Dr. Bather will perhaps forgive me if I become tedious in stating elementary, but neglected, truth.

Proof of a descriptive statement is furnished by the facts on which that statement is founded. Thus, to establish the truth that man is a mammalian vertebrate it is only necessary to indicate the breasts and the backbone. On the other hand, an hypothesis can be proved only by fresh, unlike, crucial facts—facts of such a nature that every alternative supposition is shown to be inconceivable as true. "When the hypothesis of itself, and without adjustment for the purpose, gives us the rule and reason of a class of facts not contemplated in its construction, we have a criterion of its reality which has never yet been produced in favour of falsehood." For example, if I lost coins and supposed that Mary the servant had stolen them, I should be only guessing. But if, in addition, I planted marked coins and found them in her possession, I should have proved my case with a high degree of probability. Outside biology all interpretative science is founded on adequate crucial testing—which implies an acceptance of the maxim that all relevant and verifiable facts, no matter how collected (by direct observation, experimentally, statistically, and so on), are equal before science. Thus, in effect, Newton and his successors said to themselves: "If the theory of gravitation is true, stones must fall at certain rates of acceleration, tides must follow the moon, pendulums must swing in certain times, planets must trace certain orbits, worlds must assume certain shapes," and so on, until not only was the supposition established (by disproving alternatives), but also a universe of diversified facts has been brought within its range. Hence its importance. If to-day I said to physicists, "Your terminology is loose and your scientific methods four hundred years behind the times," what would happen? I think they would

take me between finger and thumb and eat me like a shrimp.

At least one great biologist, Darwin, tried to test his supposition with Newtonian candour and thoroughness. So far as I am able to judge, disbelief in natural selection is now felt only by people who decline to submit their opposing suppositions to a similar course of rigorous testing. But, to judge from literature, as a general rule, biologists seem to think that, as in description, the facts (or similar facts) on which an hypothesis is founded sufficiently prove the truth of it. Hence, in the lack of crucial testing, the chaos of opinions. Hence the rival doctrines and schools. Hence the unending controversies. Hence the absence of truth accepted by everyone. Hence the particular value set by this sect or that on evidence collected in this way or that, and the neglect of all other evidence. Hence, its inaccuracies undetected, the perpetuation of a loose terminology. Hence, for example, the two hundred explanations of sex. All these explanations must have been guesses; or, if one was fully tested and established, biologists have not recognised it. Biology is happy in the possession of vast and diversified arrays of facts suitable for crucial testing. Biologists are unhappy in that they do not use them. Their scientific methods are four hundred years behind those of physicists, and I suppose four thousand years behind those of mathematicians. I think all biologists must agree to this, if not as regards themselves, yet as regards the prejudiced adherents of rival sects. Crucial testing is the very soul of interpretative science. It is that which guides and controls the scientific imagination. But, as religious enthusiasts, politicians, and some men of science demonstrate, if you have not been trained to use it and submit to it, it is often nothing to you.

May I, by way of example, give one instance of what appears to me wasted opportunity? I choose a subject which does not seem to have gathered sectarian odium. It is not especially easy as biological problems go. I imagine every other problem now in dispute could be solved as simply if crucial testing were employed and its results accepted. Judging from embryos, some biologists have concluded that the individual in his development recapitulates the evolution of his race. On the same, or similar, evidence other biologists have reached a contrary conclusion. Both opinions are mere guesses, and, used in this way, the facts afford no opportunities for crucial testing. But consider them from another aspect. Consider the evolution of a structure—for example, an antler—in a line of individuals A, B, . . . Y, Z.

The first rudiments of the structure appear in A. The structure increases by progressive variations in B, C, . . . L, M. But B cannot produce his own variation without recapitulating that of A. C cannot achieve his development without recapitulating first A and then B. M cannot develop without reproducing in turn every ancestor up to A. To this point the development must necessarily have been an accurate recapitulation of the life-history of the race. But now N varies retrogressively—that is to say, he omits some part of the development, and therefore of the evolution. If N reverts to K, L and M disappear from future editions of the life-history, which thus becomes inaccurate. O resumes the progression. P interpolates a variation (*e.g.* the beginning of a tine) at the stage reached by F, introducing another inaccuracy. So the evolution continues until in Z the development, recapitulating not only some of the original history, but also many additions and subtractions, presents only a vague, inaccurate, foreshortened outline of the evolution—most vague, as a rule, in its earlier parts, which have been most often repeated, and, therefore, subjected to most alteration.

> There is a history in all men's lives
> Figuring the nature of the times deceased.

This history is not told in words, but in graphic signs, in mimicry; and like a written history, copied by a thousand hands and altered to suit the times, it has become inaccurate.

To put the thing in others words: if the son copies with alterations the development of the parent, if the parent copied the grandparent, and so on up to the remotest ancestor—the unicellular represented by the germ—how is it conceivable that development can be other than a recapitulation, however inaccurate, of evolution? But inconceivability is not sure proof. It may result from the incapacity of the thinker. Turn, therefore, to crucial testing, for which facts are now available. If it be true that development is inaccurate and incomplete recapitulation, embryos should present the appearances, however vague, of ancient ancestral types. This is exactly what we find. Consider a butterfly. It begins life in the egg, where, quiescent and sheltered, it develops in an environment very unlike that in which the ancestral prototypes struggled for existence. At this stage, therefore, recapitulation should be much altered, vague, rapid, foreshortened, a mere scaffolding. The caterpillar must fight actively for existence in an environment which probably resembles closely that of its prototypes. Probably, therefore, the animal itself closely resembles its prototypes. It increases in bulk, but otherwise changes little. Quiescent and sheltered, a chrysalis, on the other hand, alters rapidly and enormously except in bulk. In the butterfly development has ceased. In man, sheltered and quiet in the uterus, there undergoing vast changes, but afterwards altering little save in bulk, development pursues the same lines. So also in every other type of multicellular being. Consider how sheltered is the development and how rapid the recapitulation in the seeds of plants, and how small, relatively, are the subsequent alterations, except in bulk.

If anyone can now think of development as other than recapitulation, he is capable of an intellectual feat beyond my powers. If I am right, I have furnished evidence that it is possible to solve even the more difficult biological problems by paying attention to the ordinary rules of scientific procedure. If I am wrong, biologists should, like the physicists, be able to eat me like a shrimp.

Here is a significant thing. No man of science, not a biologist, who knows the facts and has read what I have written will ever again be able to conceive of development as other than recapitulation; and often, when he thinks of a seed, an egg, an embryo, or a chrysalis, he will wonder what æons are being traversed within these amazing time machines—the "resting stages" of the biologists. But no biologist will be interested or will alter his antecedent opinions a hair's-breadth. He will merely be shocked at the impudence of one who is neither a botanist nor a zoologist.

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The Great Sun-spot Group and Magnetic Disturbances, May 8–21.

ON May 8 there appeared on the sun's eastern limb an equatorial sun-spot in a region which has been without disturbance for some considerable time. It was an active spot which had separated by May 12 into two large spots. The maximum area of the group was 16·5, in units 1/5000 of the sun's visible disc, and this was attained on May 14. The leader spot of the group was a composite spot containing two umbræ.

Its mean heliographic co-ordinates on that date were latitude +1·4°, longitude 6·4°. The following spot was a large single spot, and its co-ordinates were latitude 0·2°, longitude 358·8°. The whole group extended over 12° in longitude and about 6° in latitude, so that a considerable area of the sun's surface was disturbed.

The mean heliographic latitude of the earth during the passage of the group across the sun was −2·8°. Therefore, not only was there a large active sun-spot on the sun, and with the penumbral character which frequently marks spots associated with magnetic disturbance, but also the earth was very favourably situated with regard to it. Under such conditions a great magnetic storm is inevitable.

With regard to the registration of the movements of the needles during the series of magnetic disturbances, we were greatly handicapped by the non-arrival of our usual supplies of sensitive photographic paper. Even so, on the less sensitive paper we were obliged to use the records were very remarkable. As early as May 11 the D (declination) magnet was affected by some small rapid oscillations from 6h. 12m. to 8h. 12m. The next day, May 12, between 8h. and 10h., D was still more disturbed, while at 8h. 12m. H (horizontal force) showed a marked and rapid fall of 146γ.

A greater activity of disturbance began on May 13 with a "sudden commencement" at 13h. 12m. In D there was a rapid movement to east and west of extreme range 15°, and on V (vertical force) an increase, decrease, and rapid recovery, range 26γ, in about two minutes. This phase is somewhat unusual on V. Between 21h. 24m. and 21h. 36m. a rapid oscillation of D occurred, east, west, and east, range 28′. At the same time V fell rapidly and suddenly 333γ, recovered for a few moments with a slight rise at 21h. 36m., and then fell so that the spot of light was off the recording drum. At 22h. 12m. it rose again rapidly 250γ. Just before midnight there were further active movements of D and of V.

The second and more intense phase of the storm commenced on May 14 16h. On D a series of oscillations occurred of increasing speed and amplitude until 22h. 22m., when there was a sharp eastward movement of 46′. At the same minute there commenced a very rapid decrease of force in V of at least 461γ, the spot of light passing off the paper on May 15 0h. 24m., the magnet adhering to the arrests. It did not begin to give a record again until May 15 9h. 12m., when it had risen to its position before the rapid fall.

Meanwhile D was becoming more violently agitated until on May 15 0h. 45m. the spot of light passed off the drum in an eastward direction. This marked the commencement of the third, or most intense, phase of the storm, which lasted for about eight hours. The movements of D were so rapid that the paper used was not sensitive enough to register all their details. At 5h. 24m. the spot of light had reached the limits of record in the westward direction, so that the extreme range of D during the storm was greater than 2° 0′. It was not until 7h. 30m. that the movements had decreased in intensity sufficiently to be clearly legible on the curves. The spot of light was then east, and it rose west with a series of rapid oscillatory movements between 8h. and 11h., when it attained a normal position. The mean range of these oscillations was 20′.

With regard to H, the trace after May 14 22h. 25m. and during the maximum phase is completely lost owing to the inferior sensitiveness of the paper. The record is resumed on May 15 7h. 30m. This agrees with D in giving the greater and greatest intensities of the storm as occurring between May 14 22h. 25m. and May 15 7h. 30m.

On May 16 D continued to be disturbed, particularly between 0h. and 11h., with a range of 47′, the more rapid oscillations taking place between 4h. and 10h. This is a repetition as to time of the storm of the preceding day, though on a reduced scale. On H the activity was even greater than on D, the range being 329γ. On V the spot of light fell gradually, until on May 16 6h. 50m. it had passed off the paper. It came on again after about 12 minutes, and the magnet gradually resumed a normal position. The range was 410γ. The character of its trace was a long wave with superposed oscillations. During the storm the variations in V were extremely and unusually active.

Magnetically, May 17 was comparatively, though not actually, a quiet day, and May 18 was even quieter. Greater activity was resumed on May 19 20h., when the sun-spot, much reduced in disc-area, was approaching the western limb of the sun. Between 23h. and 23h. 46m. there was a well-marked peak-like movement on D, with a range of 58′. H was not so much disturbed as D. But on May 20 23h. 5m. to May 21 0h. 5m. there was a movement on H of a similar peaked character to that of D on the preceding day. The range was 212γ. V, too, was again active, range 173γ, between May 19 21h. and May 20 3h. 30m. On May 20 14h. 30m. there was resumed activity on the magnets, with rapid oscillations on D and H and an increase of force in both H and V. The series of disturbances, constituting a storm of unusual duration, had not completely subsided until May 21 20h. A. L. CORTIE.

Stonyhurst College Observatory, May 27.

The Reparation Act and Scientific Research.

PROF. PARTINGTON'S letter (NATURE, May 26, p. 394) interested me, because some months ago I pointed out in NATURE how harmful any restriction of the importation of scientific apparatus would be to some scientific laboratories, and how unreasonable the claims of the English instrument-makers appeared to me. However, no one else wrote in support of what I said and several makers wrote against it (though carefully refraining from answering my criticisms), and I almost began to think that my experience might be unusually unfortunate and that other workers were not affected, especially as NATURE in certain leading articles supported the protection of "key industries." The Gilbertian "Reparation" Act is of later date, but instances of its working are supplied in the letters of Prof. Gardiner and Prof. Partington.

Now there is not the slightest hope that the weak influence of scientific workers will affect the plans of practical politicians and Civil Service officials, especially after the recent action of the Post Office when opposed by much more powerful interests. Nevertheless, I am surprised that none of the scientific societies has taken the action of ascertaining the feeling of its members on this question. They could then either repudiate the statements of the grumblers, of whom Prof. Partington may be reckoned one, or publish some manifesto which could be placed on record as a protest against the policy of protecting scientific apparatus at the expense of science.

It is reported that the president of the Society of Glass Technology, speaking on the restriction of importation of glassware, considered that "electric lamp bulbs should also have been included in the Bill," and I agree, as that might have attracted more public attention to the effects of the Bill.

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The Cosmology of Dante.

By DR. J. L. E. DREYER.

THE study of the cosmological ideas set forth in Dante's great poem is of considerable interest, not only because it helps us to understand many parts of the poem which otherwise might appear obscure, but also because Dante is a faithful interpreter of the opinions about the construction of the universe which were prevalent in his day. In this respect he is unique among poets. In the present article we shall trace the origin and gradual development of the system of the world adopted by Dante, without entering on minute interpretations of particular passages.

The principal feature of this system is the arrangement of the universe in a series of concentric spheres with the earth in the centre (Fig. 1).

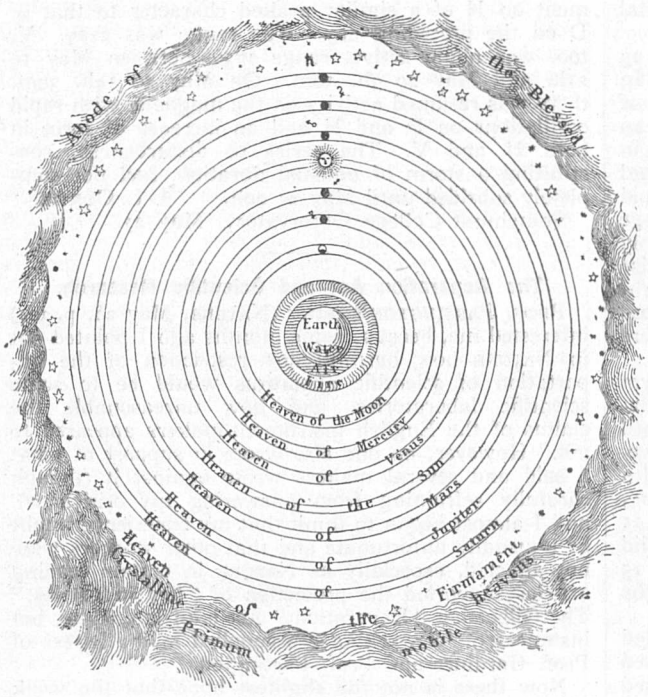

FIG. 1.—Dante's cosmical system.

This is a very old idea, originating in the most striking of all celestial phenomena, the rotation of the heavens in twenty-four hours from east to west. Eudoxus (about 370 B.C.) was the first to design a complete system of concentric spheres, arranged so as to account for this rotation of the heavens as well as for the principal irregularities in the motions of sun, moon, and planets in the opposite direction. Though Eudoxus was a great mathematician, his system of spheres could account only partially for the observed phenomena, probably because it was founded on an utterly insufficient number of observations of these phenomena. The system was much improved by Kalippus, and, what was of more importance, it was accepted by Aristotle. To him the spheres were not merely mathematical conceptions, but physically existing bodies, kept in motion by the soul of each. Notwithstanding his great authority, however, this system was rejected by the astronomers of Alexandria, chiefly because it suffered from an incurable defect, that of assuming every planet to be always at the same distance from the earth. That this is not the case is clearly shown by the variable brightness of the planets, most strikingly seen in the case of Venus and Mars.

The increased number of apparent irregularities in the planetary motions revealed by steadily pursued observations led to the development of a system of the world which finally became known as the Ptolemaic system, because the last touches were put to it by Claudius Ptolemy in the second century A.D. It assumed a planet to move on a circle, the epicycle, the centre of which moved on a larger circle, the eccentric, near the centre of which the earth was situated. Additional refinements were added to account for observed minor irregularities. But all this, though very satisfactory to mathematicians, was not to the taste of many people, who could not accept all these circles as realities, but demanded some sort of a system of spheres, not necessarily concentric. To satisfy this demand it was suggested that we might for the epicycle substitute a small sphere, to the surface of which a planet was attached, while the sphere fitted in and moved between the surfaces of two concentric spheres, near the common centre of which the earth was placed. Ptolemy, who wrote a valuable text-book on astronomy (the "Syntaxis," generally known by the Arabic name "Almagest"), wrote also, for the weaker brethren, another, called "The Second Book of Phenomena," in which a complicated system of spheres is described. But this was never a success, and the Greek original is lost, so that the book was quite unknown to modern European readers until 1907, when a German translation from an Arabic version was at last published.

Among the Arabs we find an attempt to adopt material spheres in the cosmical system of the "Brethren of Purity," a semi-religious society which arose at Basra near the end of the tenth century. They taught that there are nine spheres of different thicknesses, fitting inside each other "like the skins of an onion." The ninth sphere is the prime mover, and turns in twenty-four hours. The eighth sphere is that to which the fixed stars are attached; it revolves in a very slightly longer period, lagging behind to the amount of one degree in a hundred years. This is supposed to account for the precession of the equinoxes. Saturn (the seventh sphere) lags more, and the motion becomes slower as we descend through the spheres, until we reach the first or slowest sphere, that of the moon, which takes

about fifty minutes more than twenty-four hours to make a complete revolution. In other words, all celestial motions take place in the same direction, from east to west. This is a very old idea, several times alluded to by Plato; but the denial of the independent eastward movement of the planets could not commend itself to any Greek astronomer who realised that the planets moved in orbits considerably inclined to the direction of the daily rotation. This was also the case among the Arabs, and no prominent advocate of a system of spheres appeared among them until the rise of the Aristotelian philosophy in Spain in the twelfth century revived the belief in spheres. Al Betrugi (Alpetragius) wrote a book on the subject, in which he also let all the motions be from east to west. But though he made some attempt to account for the most conspicuous irregularities of the planetary motions, his system is not to be compared with the Ptolemaic system as regards completeness, and it could be accepted only by people who were content merely with the rough outline of a system.

Early in the thirteenth century Arabian books on philosophy and science began to be known north of the Pyrenees, and along with them came the writings of Aristotle, translated long before from Greek into Arabic, and now from Arabic into Latin. As Aristotle, who very soon was accepted as an infallible guide, had adopted a system of spheres, one outside the other, it was very difficult for his Christian admirers to do anything else. During the whole of the thirteenth century there was a running fight between the adherents of Aristotle (or Alpetragius) and those who realised that no system of concentric spheres could ever account for the observed phenomena so completely as the Ptolemaic system of epicycles and eccentrics did. By the year 1300 the fight was in France fairly well decided in favour of the followers of Ptolemy. But in Italy the study of science had scarcely made any progress; Ptolemy's great work (though translated into Latin as early as 1175 by Gherardo of Cremona) was quite unknown, and only an extremely elementary text-book by Al Fargani was used in the universities.

It was therefore natural enough that Dante should be persuaded of the truth of the doctrine of concentric spheres. Besides, this readily lent itself to poetic treatment, which a complicated set of circles could never do. There is no trace, either in the "Commedia" or in the philosophical treatise the "Convivio," of his having known the "Syntaxis" of Ptolemy. The chief source of his astronomical knowledge is the little text-book of Al Fargani, which he frequently quotes, and from which he occasionally borrows whole passages. In the "Convivio" he repeatedly makes use of the writings of the great scholastic, Albertus Magnus. In contrast with several Italian writers on astronomy even long after his time, who often displayed great ignorance, Dante shows himself well acquainted with the general phenomena of the heavens. Thus he describes correctly the apparent motions of the stars as seen from the poles of the earth or from the equator; he often indicates the time of year by mentioning the zodiacal sign occupied by the sun; he even gives a fairly closely correct value of the length of the year.

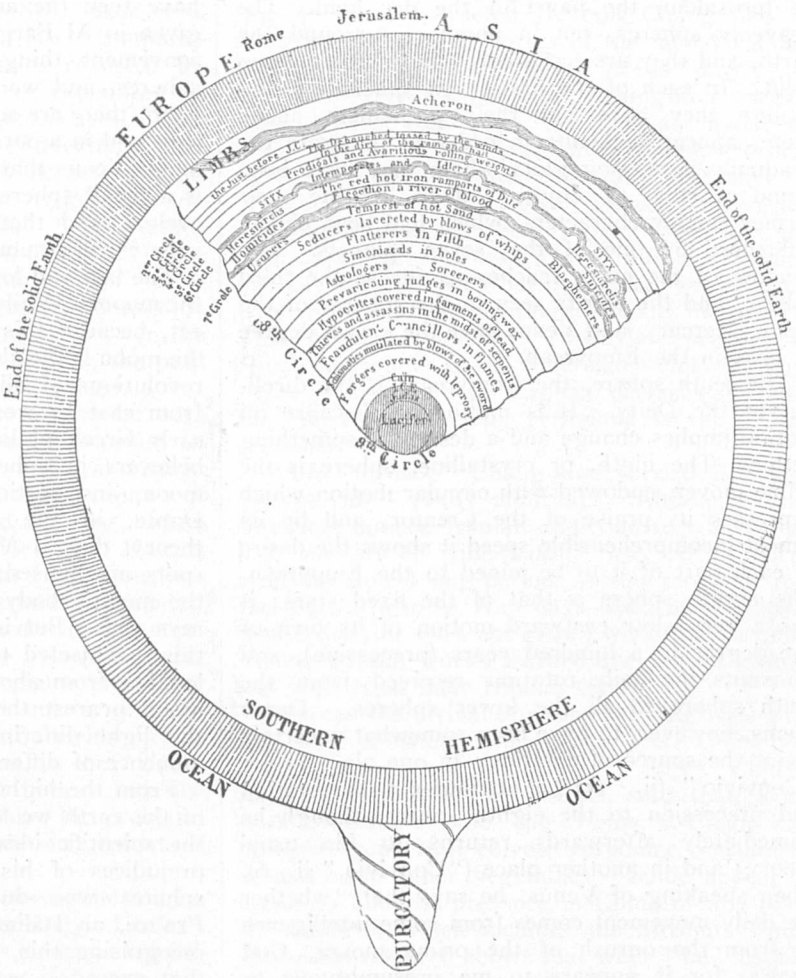

FIG. 2.—Dante's infernal regions.

In the centre of the universe is the earth, which is a sphere. These two facts were not disputed

by anybody. Hell is a conical opening reaching to the centre of the earth, where the devil dwells at the apex of the cone (Fig. 2). Among theologians this was generally accepted as the proper place for him. Even three hundred years later, when the motion or non-motion of the earth was the burning question of the day, the idea appeared very shocking to many that a body having the devil in the middle could be supposed to travel among the heavenly bodies, which were moved by angels. Purgatory is a large conical hill, rising out of the vast ocean at a point diametrically opposite to Jerusalem, the navel of the dry land. The heavenly spheres, ten in number, surround the earth, and they are repeatedly alluded to as being solid. In each of the first seven spheres spirits, though they have not their permanent abode there, appear to Dante in order to illustrate the gradually increasing glory which they have been found worthy to enjoy, and to indicate their former earthly characters, which had been chiefly influenced by one of the seven planets. The shadow of the earth reaches as far as the third sphere, and the spirits seen in the spheres of the moon, Mercury, and Venus have the lowest degree of bliss in the Empyrean.

The tenth sphere, the Empyrean, is the dwelling of the Deity. It is motionless, because all motion implies change and a desire for something better. The ninth, or crystalline, sphere is the prime mover, endowed with circular motion which expresses its praise of the Creator, and by its almost incomprehensible speed it shows the desire of each part of it to be joined to the Empyrean. The eighth sphere is that of the fixed stars; it has a very slow eastward motion of its own of one degree in a hundred years (precession), and transmits the daily rotation received from the ninth sphere to all the lower spheres. Dante seems, however, to have been somewhat uncertain about the source of rotation: in one place in the "Convivio" (ii., 15) he attributes both rotation and precession to the eighth sphere, though he immediately afterwards returns to his usual theory; and in another place ("Convivio," ii., 6). when speaking of Venus, he says that "whether the daily movement comes from some intelligence or from the onrush of the prime mover, God knows, for it appears to me presumptuous to decide." But these passages seem only to indicate some momentary hesitation between the conflicting statements of his sources. In the same way he is doubtful about the nature of the Milky Way, whether it is composed of stars or of vapour. He is particularly disturbed by the difference between the "new" translation of Aristotle (by Thomas Aquinas, from Greek) and the "old" one (by Michael Scot, from Arabic), but he inclines to the statement of the latter, that it is a multitude of stars.

The nine revolving spheres are moved by the three triads of angelic intelligences, the Seraphim as the highest in rank directing the ninth sphere, while the angels govern the lowest sphere, that of the moon. The planets were supposed to move in the plane of the ecliptic. There is no mention of the motion being eccentric, though Dante must have seen the account of the eccentric circles given in Al Fargani's book. But these were inconvenient things to believers in a system of spheres, and were better ignored. On the other hand, there are several allusions to epicycles; thus it is said in a paragraph in the "Convivio" (ii., 4) about Venus that on the circle of its sphere there is a small sphere which astronomers call an epicycle, "and though we say that there are ten spheres, this number does not comprise them all."

The last and lowest of the ten spheres is that of the moon. While the motion of Saturn is the swiftest, because this is most divine motion, that of the moon is the slowest ("Paradiso," iii., 51). The revolutions of all the nine spheres are therefore from east to west as supposed by some of the early Greek philosophers and by all the Arabian believers in spheres. As to the nature of the moon, and particularly of the surface-markings, Dante, in the "Convivio" (ii., 14), adopts a theory, due to Averroes, according to which the spots are caused by the rarity of some parts of the moon's body which do not reflect the sun's rays well. But in the "Paradiso" (ii. and xxii.) this is objected to, and the spots, which Dante, looking from above, sees only on the side of the moon nearest the earth, are said to be due to the light differing in various places under the influence of different angelic guides.

From the highest heavens to the lowest depths of the earth we find in Dante a faithful guide to the scientific ideas as well as to many popular prejudices of his time. Though the theory of spheres was during his lifetime defeated in France, an Italian may well be pardoned for not recognising this, particularly when we remember that even 200 years later two separate attempts were made in Italy to set up scientific theories of concentric spheres. To the student of the history of science it is a never-failing source of pleasure to find medieval cosmology so beautifully illuminated in the writings of the great Florentine poet.

The Natural History of Cultivated Plants.[1]

CLASSICAL plant-names like Μηδικὴ πόα or *spina Arabica*, designed to indicate origin, do not always fulfil their object. Pliny's specific reference to *milium intra hos decem annos ex India in Italiam invectum* has not obviated debate as to the home and the identity of his plant. Many notices of ancient crops connote only local cultivation.

Renaissance naturalists connected their culti-

[1] "Sino-iranica. Chinese Contributions to the History of Civilization in Ancient Iran, with special reference to the History of Cultivated Plants and Products." By Berthold Laufer. (Field Museum of Natural History Publication 201: Anthropological Series, vol. xv., No. 3.) Pp. iv+445. (Chicago, 1919.)

vated plants with those mentioned by classical authors. In medieval "mysteries" a "maple" replaced συκόμορος. This tendency outlived the finding of America. When the Peruvian "papas" reached Artois from Rome, Clusius asked if here were ἀράχιδνα. Nor did scholars always agree. When the "sunflower" was first described in 1568 it was compared by Dodoens with the "coronary" Bellio, and by Cortuso with the "aromatic" Laserpitium.

The habit weakened as knowledge increased. But the history of cultivated plants was left to scholarship until R. Brown, in 1818, made it a branch of botanical geography. His "comparative view" of the esculent species reported by C. Smith and Lockhart during an expedition to the Zaïre dealt with the Guinea coast as scholars had treated the lands of the Mediterranean littoral. Necessity guided this action; Congo crops lie outside "letters." Alphonse de Candolle, whom Laufer calls "the father of the science of historical botany," explained in 1855 that the chapter on cultivated plants in his "Géographie botanique raisonnée" was partly inspired by Brown. In the "Origine des plantes cultivées" of 1883 the path Brown had opened up was again followed.

The results secured in 1855 by a botanist with historical instincts induced Hehn to ascertain in 1870 what scholarship guided by natural history tastes can accomplish. The limitations of "letters" were tacitly admitted in 1894, when Schrader, in his revision of Hehn's "Kulturpflanzen und Hausthiere in ihrem Uebergang aus Asien," sought aid from an eminent botanist. Thiselton-Dyer has shown, when elucidating complex subjects like ἄμπελος τῆς Ἴδης, that the successful student of cultivated plants should be both an accomplished botanist and a polished scholar. Collaboration occasionally yields mosaic results; regarding Engler's notes on the "vine," Laufer remarks that "it is not botany but historical research that is able to solve the problems connected with the history of our cultivated plants."

Hehn's "Kulturpflanzen" discusses the migration of Asiatic crops to Greece and Italy. Laufer's "Sino-iranica" presents Chinese evidence regarding ancient Iranian rural economy. The two purposes induce differences in outlook and treatment. The method of Laufer deviates from that of Schrader and Engler much as that of Brown departs from the methods of Gesner and Clusius.

Laufer employs history so effectively as almost to condone the acerbity of his criticism of others. He teaches us that sinologues enjoy advantages denied to classical scholars, since Chinese notices of useful plants lend themselves to historical treatment more readily than Hebrew, Greek, or Latin allusions. The Chinese, Laufer concedes, have shown thought and common sense when trying likely exotic crops. Their long series of encyclopædias, sometimes in several editions, afford approximate dates for many plant-introductions. The culture and influence of China increased gradually. If, like Rome, China suffered many invasions, she rarely succumbed to foes so destructive as the Vandal or so malignant as the Turk. Her civilisation remained little affected; the introduction of new plants never induced in China economic revolutions comparable with that experienced in Britain through the arrival of our staple root-crops.

Problems connected with the history of Chinese cultivated plants present familiar difficulties. Chinese records of introductions from Iran began two thousand years ago. The emperor Wu (140–87 B.C.) instructed General Chang-kien to fetch from Ferghana horses of the famed Iranian breed. Finding that these steeds throve on "lucerne" (*Medicago sativa*), Chang-kien carried home seed of this crop. As the plant had been established in Greece four hundred years earlier, we have some assurance regarding the home of Μηδικὴ πόα. With μηλέα Περσική and μῆλον Ἀρμενιακόν matters are different; "peach" and "apricock" are Chinese plants, and the Iranian gift of "alfalfa" was but a payment on account. Later history affords instances equally instructive. The "Langka mirich" (=Ceylon pepper) of Hindu husbandry is the American "chillie" (*Capsicum frutescens*); to English denizens in India the American *Physalis peruviana* is the "Cape gooseberry."

With "medick" Chang-kien carried back the "grape-vine" (*Vitis vinifera*). Although Han travellers noticed Iranian addiction to wine-drinking, the art of wine-making was not acquired until the later T'ang period. It was received from the Turks, who in Han days lived in Mongolia, where the vine does not grow; when they invaded Turkestan the Turks learned the use of grapes and wine from their Iranian serfs.

Between the arrival of grape-growing (120 B.C.) and that of wine-making (640 A.D.) China obtained many western crops. Later Chinese naturalists, thinking backwards, state that, along with "alfalfa" and the "vine," Chang-kien brought from Iran chives, coriander, cucumber, sesame, and other vegetables. Some appear to credit to him the presence in China of any plant the name of which includes the attribute "hu." Historical research shows that while "hu" usually implies western origin, it affords no absolute criterion; even when a "hu" plant is really from the west, it need not be from Iran. The English misconception that our "potato" originated in Virginia and was introduced by Raleigh shows that the "process of retrospective thought" is not peculiar to China. Western misapprehension may exceed Oriental; our "potato" (*Solanum tuberosum*) is not the "patata" (*Ipomoea Batatas*).

The period 200–400 A.D. saw the establishment of trade relations with Po-se in Nan Hai. In A.D. 461 an embassy from Po-se in Iran reached Wei. After this event products of the southern Po-se were sometimes thought to be western ones, while Persian plants were occasionally regarded as Malayan. Europe has had the same experience. The navigators who first made American

landfalls believed they had reached India; those who stayed at home sometimes mistook West Indian for East Indian products. The "gallopavo" (*Meleagris gallopavo*) came to Europe in 1541. Its French popular names—"dindon" and "dinde"—leave open the question of origin; the English popular name "turkey-cock" indicates a belief that the bird came from the East. The French do not, however, claim greater perspicacity because of this; when "maize" (*Zea Mays*) first appeared they termed this cereal "blé de Turquie"; we, with fortuitous caution, used the non-committal name "Indian corn."

One undoubtedly western introduction attributed to Chang-kien is "hwan lan" (*Carthamus tinctorius*). The biography of the general and the annals of the Han contain nothing to this effect, and this introduction cannot antedate Tsin times (200–400 A.D.). This plant, which was unknown to classical writers, is the Arabic "kurtum"; its dried flowers, the Arabic "usfūr," came to medieval Europe under the Italian trade-names "asfiore" and "saffiore," our "safflower." The Chinese confused this product with "yü-kin," our "saffron," the dried stigmas of *Crocus sativus*; the two were colloquially termed "hun hwa" (=red flower). One of the uses of the dried flowers of "hwan lan" provided the plant with the alternative name "yen-chi," and thus led to its confusion with an indigenous "yen-chi" (*Basella rubra*), tinctorial in all its parts. Matters were further complicated by the existence of Mt. Yenchi and by the homophony of the Chinese name "yen-chi" (=cosmetic) with the Hiun-nu word "yen-chi" (=royal consort). It is scarcely surprising that Chinese disquisitions on "yen-chi" are more remarkable for their graceful style than for their historical accuracy.

The natural history of European economic products supplies problems equally complicated. The Greeks gave *σκορπίουρον*, the inflorescence of which is circinal, the alternative name *ἡλιοτρόπιον* because it flowers at the summer solstice. They distinguished two sorts of *ἡλιοτρόπιον*—*τὸ μέγα*, found in dry situations, and *τὸ μικρόν*, confined to damp places. No Greek text asserts that the blossoms of *σκορπίουρον* open only in bright sunshine or follow the sun from morn until eve. In spite of this some Latin authors regard Heliotropium as one of the "helioscopia," while others include it among the "solsequia." The Aramaic equivalent of *ἡλιοτρόπιον* is either "somar yauma" (=day turning) or "smar yauma" (=day-turned), so that in Syria the plant identified with that of the Greeks was one which the Romans, at least, would have included among their "solsequia." Arab naturalists identified "somar yauma" with the "tharanchul" of Andalusia. This Spanish "tornesol" (*Chrozophora tinctoria*) was in 1554 identified by Amatus Lusitanus with *ἡλιοτρόπιον τὸ μέγα*; in 1557 Clusius decided that it was *ἡλιοτρόπιον τὸ μικρόν*.

While our earliest records of *Chrozophora tinctoria* thus happen to be Iberian, Languedoc is the only region in which the economic product of the plant was ever systematically exploited. The Spanish name "tornesol" may therefore be, as we know the French name "tournesol" certainly is, only a local variant of the Provençal word "tornesola." Tournefort tells us that what we now know as *Chrozophora tinctoria* is the plant *ex qua paratur* Tournesol *gallorum* (=litmus) as contrasted with "Tournesol *lusitanorum*" (=cochineal). Pomet informs us that of the three distinct kinds of "French tournesol" known to commerce in the seventeenth century, only that termed "tournesol en drapeau" was prepared from this plant. The French term "tournesol," like the Chinese term "yen-chi," is therefore primarily the name of a commercial article colloquially transferred to the plant which yields it. The identification of "tornesol" with *ἡλιοτρόπιον*, propounded by two distinguished scholar-naturalists, teaches us that scholarship may prove as imperfect an instrument in solving problems connected with the history of cultivated plants and products as Laufer has found botany to be. Though both names are capable of conveying the same meaning, historical research shows that here "tournesol" involves a poetic comparison of the colour-change of an alterable dye with the hues of dawn and sunset, while *ἡλιοτρόπιον* supplies a prosaic intimation as to the season of the year at which a particular plant blossoms.

The difficulties which beset the conscientious study of European cultivated plants justify the remark made by T. Johnson in 1633 that "those that vulgarly impose names upon plants have little either judgment or knowledge of them." If the task of the historian of Chinese plants and products be less troublesome, this should lend support to the conclusion of Laufer in 1919 that "the Chinese were thinking, sensible and broad-minded people." However this may be, economic botanists of all nationalities will join to the penitence they feel for those shortcomings on their part which Laufer so unsparingly condemns a lively gratitude for the fund of information supplied by him in "Sino-iranica."

Obituary.

Prof. E. J. Mills, F.R.S.

DR. EDMUND JAMES MILLS, formerly professor of technical chemistry in the West of Scotland Technical College, Glasgow, who died on April 21, was born in London on December 8, 1840. He received his early education at the Grammar School, Cheltenham, and later at the Royal School of Mines, London. The chemical instruction for students at the School of Mines was in those days given at the Royal College of Chemistry in Oxford Street, and there Mills worked during the later 'fifties, having as a fellow

student Herbert McLeod, afterwards professor of chemistry at the Coopers Hill College, with whom he formed a life-long friendship. At that time the only institution granting degrees in pure science was London University, and Mills utilised his education at the School of Mines with the intention of proceeding to such a degree at a later period. He obtained his Bachelor of Science degree in 1863 and the Doctorate in 1865, his name appearing in the list of graduates at a date intermediate between those of Prof. Crum Brown in 1862 and Sir Wm. Tilden in 1871. In 1861 he went as an assistant to Dr. John Stenhouse, having Tilden as one of his colleagues in that laboratory.

In 1862 Mills was appointed one of the demonstrators of chemistry in Glasgow University under Prof. Thomas Anderson, his chief duty being the conduct of tutorial classes in connection with the medical curriculum. This particular duty was by no means congenial to Mills, and his own perfect knowledge of his subject made him somewhat impatient with the backwardness of the majority of first-year medical students; with advanced students, however, and in the laboratory, he was a good teacher.

Anderson was then working on the products from the destructive distillation of coal and shale, and when not engaged in teaching duties Mills assisted him in that work. This brought him in contact with several people in Glasgow, notably John Young and others, who were interested in the oil industry, which at that time was attracting considerable attention in the Lanarkshire and Lothian districts. The friendships made in these early days may have had some influence in inducing Mills to return to Glasgow, as he did at a later date, but in 1865 he resigned his position as demonstrator at the university and returned to London.

In 1870 Mr. John Young founded the "Young Laboratory" in Anderson's College, Glasgow, a laboratory intended by him to be associated essentially with technical chemistry. The first superintendent of this laboratory was W. H. Perkin, sen. (1870–71), followed by G. Bischof (1871–75); they were succeeded by Mills in 1876.

About 1886 the "Young Laboratory" together with Anderson's College was incorporated in the Glasgow and West of Scotland Technical College, and became the "Young Chair of Technical Chemistry." This appointment Mills held until his resignation in 1891.

Papers recording Mills's original work are published in the proceedings of the Royal Societies of London and Edinburgh, the *Philosophical Magazine*, and the journals of the Chemical Society and the Society of Chemical Industry in London. They are numerous and of a varied nature. His first paper, given to the Royal Society in 1860, was on bromo- and chloro-phenyl, but his early work dealt more with questions on the general principles of chemistry and inorganic chemistry, such as isomerism, electric attraction, chemical mass, and chemical equivalents. In the Journal of the Chemical Society he published papers on aniline derivatives and nitrotoluene, potable waters, chemical repulsion, and melting points. From 1879–82 he published in four parts "Researches on Chemical Equivalents," "Investigations on the Action of Oxides on Salts," and in conjunction with Mr. Louis Campbell about 1879 "Researches on Dyeing." At a later period, on the foundation of the Society of Chemical Industry, he gave to that society papers on the quantitative estimation of oils and fats, viscosity determinations, and the oxidation of aniline. In the Proceedings of the Royal Society of Edinburgh he published researches on thermochemistry.

In the four small works which he published Mills did not confine himself to purely scientific subjects; in addition to two books, "Fuel and its Applications," in conjunction with E. J. Rowan, and "Destructive Distillation," he wrote a volume of poems, "My only Child," published in 1895, and "The Secret of Petrarch" in 1904.

After retiring from the professorship at the Glasgow and West of Scotland Technical College Mills returned to London, where he occupied himself with various pursuits, among them photography, which he had practised with considerable skill from early days. A certain deafness which overcame him during later years tended to increase a reserve of manner which Mills always possessed, but he continued until a short time ago to attend the meetings of the various societies to which he belonged, and was to be found regularly once a week at the Athenæum Club, where he met his more particular friends. He had a good knowledge not only of scientific, but also of general literature, and held some distinct views on religious questions; these, however, he never discussed.

Mills was elected a fellow of the Royal Society of London in 1874. He became a fellow of the Chemical Society in 1862, serving several times on the council, and as a vice-president from 1912 to 1915. He was an original member of the Society of Chemical Industry, and for a period president of the Glasgow and West of Scotland section of that society. He received the honorary degree of LL.D. from the University of Glasgow.

J. M. T.

DR. GEORGE FREDERICK WRIGHT, who died recently at the age of eighty-three years from heart failure following influenza, was, from 1881 to 1907, a professor in the Oberlin Theological Seminary, Ohio, and had been since 1884 the editor of a well-known theological publication, "Bibliotheca Sacra." His most important work, however, was done as a geologist, and his "Ice Age in North America," first published in 1889, remains a standard work on the subject. He wrote also on "The Glacial Boundary in Ohio, Indiana, and Kentucky," "Man and the Glacial Period," and "Greenland Icefields." At the invitation of the late Tsar of Russia Dr. Wright visited Siberia for

a geological study, the fruits of which appeared in 1902 in a two-volume work entitled "Asiatic Russia." The relations of science and religion were also discussed by him in several of his publications.

WE regret to announce the death, on May 28, at sixty-four years of age, of MR. R. E. DENNETT, author of "At the Back of the Black Man's Mind," "Nigerian Studies," "West African Categories," and other works.

Notes.

OWING to the postponement of the sailing of the *Celtic*, on which he had booked his passage from America, Prof. Einstein is unable to lecture at King's College, London, until Monday, June 13, at 5.15 p.m. All the tickets which have been issued for June 9 will be available for that date.

SEVERAL changes have recently been made in the scientific staff of the Australian Museum, Sydney. Dr. C. Anderson, who has been mineralogist since 1901, succeeds the late Mr. R. Etheridge, jun., as director. Mr. A. Musgrave fills the vacancy caused by the death of Mr. W. J. Rainbow, entomologist, and Messrs. J. R. Kinghorn and E. le G. Troughton, second-class assistants, have been promoted to be first-class assistants in charge of reptiles, birds and amphibians, and mammals and skeletons respectively.

MR. W. L. G. JOERG, of the scientific staff of the American Geographical Society of New York, and editor of its Research Series, left on May 21 on a six months' leave of absence for a trip to Europe on behalf of the society to study the present status and tendencies of geography in Europe and to establish closer relations with kindred workers and institutions. During his trip Mr. Joerg expects to visit most of the universities where modern scientific geography is represented. Communications to him may be addressed c/o Messrs. Brown, Shipley and Co., 123 Pall Mall, London, S.W.1.

AT the anniversary meeting of the Linnean Society of London on May 24 the Linnean gold medal of the society, the highest award in its gift, was presented to Dr. Dukinfield H. Scott, and all who know the value and extent of his services to recent and fossil botany during the last forty years will agree that the award is thoroughly deserved, and some may be disposed to wonder why it was not bestowed earlier. The medal was instituted in 1888 on the occasion of the centenary of the foundation of the society, and is given in alternate years to a botanist and a zoologist who at the time of the award is not on the council. Dr. Scott's services as councillor, secretary, and president of the society have been almost continuous, so that the opportunities of making the gift have been very few until the present year.

THE Mount Everest Expedition started from Darjeeling in two parties on May 18 and 19. The staff of the expedition consists of Col. Howard Bury, the leader, Mr. H. Raeburn, Dr. Kellas, Mr. G. L. Mallory, and Mr. G. H. Bullock, Alpine climbers; Mr. A. F. Wollaston, surgeon and naturalist; Dr. A. M. Heron, geologist; and Major H. T. Morshead and Capt. O. Wheeler, survey officers. Col. Bury's first dispatch to the *Times* contains particulars of the organisation and start. Major Morshead, with two assistants and fifty coolies, left Darjeeling in advance, going by the Teesta Valley to correct some of the Sikkim maps. He was to rejoin the main expedition on June 1 at Khamba Dzong. The principal transport of the expedition consists of 100 Chinese and Tibetan mules, with drivers drawn from hill tribes and accustomed to long marches. Forty Sherpa coolies, mostly from villages south or south-east of Everest, accompany the expedition. Several of them have been with Dr. Kellas on high climbs and are trained in ice-work. Mr. Wollaston is taking two Lepcha collectors and skinners to assist in biological work. The expedition has a complete photographic equipment, and every camera can be used for telephotographic work. Arrangements have been made for developing the plates and films on the spot. Col. Bury records with gratitude the help afforded by the Government of India, the Indian railways, and the Governor of Bengal (Lord Ronaldshay).

THE secretary of the Institution of Electrical Engineers informs us that, in view of the continuance of the coal strike, the Scottish Committee has reluctantly decided to cancel the proposed summer meeting of the institution.

THE autumn meeting of the Iron and Steel Institute will be held, by invitation of the Comité des Forges de France, in Paris, on Monday and Tuesday, September 5 and 6. At the conclusion of the meeting in Paris alternative visits have been arranged to works in Lorraine and in Normandy, and a party of the members has been invited to visit the Creusot works of MM. Schneider and Co.

TWO notices of memorials to distinguished men of science appear in the *Revue scientifique* of May 14. The first refers to the monument erected to the memory of Wurtz the chemist at Strasbourg, which will be dedicated on July 5 next. The other notice deals with the centenary of Ampère's discoveries in electricity. Electrical engineers in France are taking steps to restore the tomb of the celebrated physicist in the cemetery of Montmartre.

THE annual meeting of the British Science Guild will be held at the Goldsmiths' Hall on Wednesday, June 8, at 3 p.m. Lord Montagu of Beaulieu, president of the Guild, will present the annual report, and there will be addresses by the Very Rev. William R. Inge (Dean of St. Paul's) on "The Road to Ruin and the Way Out" and by Sir Richard A. S. Redmayne (chairman of the Imperial Mineral Resources Bureau) on "The Importance of Research in Promoting the Development of the Mineral Industries." Tickets may be obtained from the Secretary, British Science Guild, 6 John Street, Adelphi, W.C.2.

AT the annual meeting of the Royal Society of Victoria, held on March 10 last, the following officers were elected:—*President:* Prof. Ewart. *Vice-Presidents:* Mr. F. Wisewould and Prof. Laby. *Hon. Treasurer:* Mr. W. A. Hartnell. *Hon. Librarian:* Mr. A. S. Kenyon. *Hon. Secretary:* Mr. J. A. Kershaw. *Members of Council:* Prof. Osborne, Dr. Summers, Dr. Baldwin, Mr. Dunn, Mr. Richardson, and Mr. Picken. In the annual report it was announced that the scheme for giving short popular lectures on subjects of general interest would be continued. At the ordinary meeting which followed Sir Baldwin Spencer contributed a paper entitled "Blood and Shade Divisions of Australian Tribes."

IT is announced that Mr. Bridgeman, Secretary for Mines, has appointed an Advisory Committee for the Metalliferous Mining Industry, of which Sir Cecil Lindsay Budd is chairman. In addition to representatives of owners and of workers in mines and quarries, the following have also been appointed:—Mr. T. Falcon, Dr. F. H. Hatch, and Mr. F. Merricks, mining engineers; Mr. F. W. Harbord, metallurgist; Mr. T. C. F. Hall, Prof. H. Louis, and Dr. J. M. Maclaren, economic geologists; Mr. J. J. Burton, representing the iron and steel industry; and Sir Kenneth W. Goadby, representing medical science. Mr. F. C. Starling, of the Mines Department, will act as secretary to the Committee.

THE London University College Hospital Ladies' Association was founded twenty years ago "to provide clothes for use in the wards, and also for necessitous patients on their convalescence or discharge from the hospital," and "to take up any other work in connection with the hospital which from time to time may commend itself to a general meeting of the association." It has been remarkably successful. There are now some eight hundred members; besides the central London body, there are ten local branches. The latest development is the establishment of the infant welfare department. Like all other London hospitals, University College Hospital is in financial difficulties. In order to help, the Ladies' Association has arranged to hold a sale on Wednesday, June 8, from 11.30 a.m. to 7 p.m. at Someries House, Regent's Park. Her Highness Princess Helena Victoria has graciously consented to open the sale. The things offered for sale will be of a varied nature, including fruit and other farm and garden produce. There will also be some special features, such as an antique stall and a second-hand book stall which may interest our readers.

ON April 2 last, the Governor-General of New Zealand, Lord Jellicoe, formally opened the Cawthron Institute in Nelson, South Island. The institution was founded under the terms of the will of the late Thomas Cawthron (NATURE, January 1, 1920, p. 442) to provide a place for teaching and carrying out scientific research relating to the industries of Nelson and of the Dominion. Lord Jellicoe paid eloquent tribute to the great public generosity of the late Mr. Cawthron, and then spoke of the importance of scientific research. For an agricultural community to achieve success the agriculturists must co-operate with men of science. The work undertaken in the new institute will deal largely with problems of agriculture, fruit-growing, etc., and should therefore exert great influence on the prosperity of the whole of the Dominion. The Bishop of Nelson, who is chairman of the trustees, also addressed the gathering, and made particular mention of the library of scientific books belonging to the institute, which it was hoped, when completed, would be the best in Australasia. Prof. Easterfield, director of the Cawthron Institute, gave a brief outline of the many lines of research now occupying the attention of the staff; soil surveys, experiments with fertilisers and cover-crops, fire-blight, the deterioration of trout, fruit pests, and the utilisation of flax-waste were among the problems mentioned.

THE *Geographical Review*, issued by the American Geographical Society of New York "upon the adoption of a programme of intensive research," has in the present year ceased to become a monthly periodical; in future it will be issued as a quarterly. We welcome this change of form, as it gives an opportunity for more detailed papers on the subjects to which this valuable publication is devoted. In its new form it contains several important articles, one of the more interesting being an elaborate essay on "The Evolution and Distribution of Race, Culture, and Language" by Dr. Griffith Taylor, of the University of Sydney. This article raises questions which it is impossible to criticise in detail. The author proposes to show that "many current opinions with regard to the mixing of nations are not supported by ethnology." On the problem of the half-caste he is disposed to think that "in many cases the ethnic deterioration is too slight to be important, and that racial antipathy rather than racial degeneration is largely to blame for the troubles of the Eurasians. As regards the Alpine, Mongolian, and most Amerind and Polynesian peoples, the future seems to me to be most promising. It is our diseases and our vices, especially the use of alcohol, which constitute the so-called 'overpowering effect of the white civilisation' upon the uncivilised nations."

A PARAGRAPH in NATURE of July 1, 1920, p. 558, referred to a report of the Smithsonian Institution in which Mr. C. M. Hoy made some comments on the extermination of Australian native fauna. We quoted some of Mr. Hoy's remarks, concluding with the words:—"There are very few game laws in Australia, and no one gives any attention to the ones that are in order." The Minister of Industry, South Australia, afterwards wrote through his secretary objecting to Mr. Hoy's statement, and his letter was published in NATURE of November 18, 1920, p. 377. Mr. Hoy in a communication dated from Sydney, New South Wales, on March 12, claims that his original statement was correct, and adds:—"Everywhere I went in South Australia I found flagrant disregard of the Animals and Birds (Protection) Act, not only in the 'out-back areas,' but within a few miles of Adelaide itself." As Mr. Hoy's notes were originally published by the Smithsonian Institution, and we merely quoted from them, his letter was submitted to the institution, the acting secretary of which

now informs us under date May 7 that "while Mr. Hoy is collecting specimens in Australia for the Smithsonian Institution, he is in no sense an officer of the institution." A letter has therefore been sent by the institution to the Minister of Industry, South Australia, expressing regret that anything written by Mr. Hoy should have led to misunderstanding, and gratefully acknowledging "the kind assistance given Mr. Hoy both by the authorities and private citizens in the various parts of Australia which he has visited."

SIR HERCULES READ in his presidential address to the Society of Antiquaries (*Antiq. Journal*, vol. i., pp. 167–82, July, 1921) avails himself of his approaching freedom to deliver some home-truths. "The contents of a museum take precedence of the building that contains them." Disregard of this principle and of the views of the museum officers by two distinguished architects has made the Victoria and Albert Museum and the northern annex to the British Museum "deplorable and costly mistakes." (Sir Hercules says this would not occur in the case of a laboratory. Well, there is such a building recently erected to the plans of one of these architects in which the best light is given to passages and the windows of the work-rooms are obscured by useless balustrades and overhanging arches.) The Government has allotted to London University a site that will soon be required by the expanding British Museum. Congestion may be in part relieved by removing objects from exhibition into store; but this is only to postpone the inevitable removal of either the museum collections or the national library to another site. Lastly, the recent trouble with Scotland over a battered gravestone leads Sir Hercules to condemn the stringent embargo which several countries have laid on the export of all—even their most trivial—antiquities. At any rate, we shall all agree that for the British Isles, if not for the British Empire, the British Museum should be the centre where a complete representation of all products of Nature and art can be seen. We need, instead of competition, intelligent co-operation between the various museums.

THE mode in which the narrow-mouthed lamprey (*Geotria stenostoma*, Ogilby) ascends waterfalls is described by Mr. D. A. Herbert in the Journal of the Royal Society of Western Australia (vol. vi., part i., 1920). The animal can obtain hold only on a wet surface, and the cutting off of the water by a hand placed above the fish causes it at once to drop back into the pool. Two excellent photographs are given of the toilsome climb.

IN a second important paper on the structure of the Andes (Quart. Journ. Geol. Soc., vol. lxxvi., p. 1, 1920) Mr. J. A. Douglas points out that the Alpine type of overfolding cannot be traced in the Andean Cordilleras, and that the chain is due to vertical uplift between two ancient resistant masses which from time to time have compressed a series of transgressive deposits between them. The author continues the fine series of photographic plates that characterised his previous paper published in 1914.

DR. C. D. WALCOTT, secretary of the Smithsonian Institution, has informed the Rev. T. R. R. Stebbing that since the appearance of Raymond's memoir on the trilobite he has reviewed his own trilobite sections, and also cut a number of additional sections, one of which, fortunately, cuts across the exopodite so as to show its structure and the relations of the fringe of filaments to the spiral arm. Other sections indicate that the ventral limb was formed of a coxopodite, endopodite, and exopodite, and, in addition, a short, flat epipodite with numerous long, strong filaments. Dr. Walcott has also succeeded in securing photographs of the epipodites of Neolenus, which illustrate the difference between them and the exopodite.

AN interesting paper by Mr. Leslie Scott on "Agricultural Co-operation" appeared in the April issue of the *Fortnightly Review*. In the author's opinion, the farming community—especially the class of small farmers—exerts a considerable stabilising influence in the nation, and it is therefore highly desirable that this class should be maintained. Farmers have to face foreign competition, and they have to stimulate home demand; the best way to do these two things is to cut down wherever possible the expenses incurred in distribution and in the purchase of feeding-stuffs, etc. "Factory" farms reduce production costs, but they also eliminate the small farmer, for the factory farm consists of 10,000–20,000 acres farmed by a manager appointed by some company. Agricultural co-operation seems to be the only method by which economic production can be attained and the small farmer preserved at the same time. A great deal is done by such co-operation in Denmark, and there are a few agricultural societies doing good work in this country, but there is a great need for union among these different societies. They are now being joined up in the Agricultural Wholesale Society, and as soon as the farmers put implicit trust in their own societies and the societies place equal trust in the central body, then the wholesale society—provided that it is adequately capitalised—will be able to make practically its own terms in the markets both of this country and of the world.

THE Douglas fir, *Pseudotsuga Douglasii*, the most valuable conifer in western North America, is now planted extensively by foresters in this country, as it produces a large volume of timber in a short period of years. Until recently this tree enjoyed practical immunity from both insect attack and fungus disease, but this happy state no longer exists, and it is necessary now to sound a warning that unless preventive measures are taken, great disaster may befall plantations of this species. Such has happened in the case of the white pine, *Pinus strobus*, an American tree that can no longer be commercially planted in Europe on account of its liability to succumb to the deadly fungus *Peridermium strobi*. The Douglas fir is becoming infested in the South of England with a woolly aphis, *Chermes Cooleyi*, which was first noticed in 1914 in the New Forest. Its spread since then has been alarmingly rapid, and isolated attacks were noticed last summer in Peeblesshire. It is distressing to hear also of a fungus which has been

doing considerable damage of late years to young plantations of Douglas fir in many parts of Scotland. This either kills the leading shoot a few inches below the tip or causes the death of the whole tree by attacking the outer tissues completely round the stem at a little distance above ground-level. In both cases there is a sudden decrease in diameter in passing from the healthy to the diseased portion of the stem, accompanied by much exudation of resin. This fungus is described as a new species, *Phomopsis pseudotsugae*, by Dr. Malcolm Wilson in the Transactions of the Royal Scottish Arboricultural Society (vol. xxxiv., part ii., pp. 145–49, plates iv.–v.) published in November last. Early recognition of the disease and burning of affected trees are the measures recommended for stamping out this pest, which has been known to kill half the trees in a young plantation.

A LENGTHY paper on "The Perishing of Paper in Indian Libraries" forms part vii., vol. iii., of the Journal of the Indian Institute of Science. The investigation was undertaken at the Institute of Science on behalf of the Government of India by Mr. J. J. Sudborough and Miss M. M. Mehta. "Perishing" is defined as a brittleness which is so marked that folding the paper once or twice will cause it to break along the fold, and it is observed in many of the books in record offices and libraries. The conclusions which the investigators have arrived at as the result of an examination of numerous libraries in India do not differ greatly from the report of the Committee on the Deterioration of Paper in Europe published in the Journal of the Royal Society of Arts for 1898 (No. 46), or from the report of a similar committee in America which appeared as Report No. 89, Pub. 1909, U.S. Department of Agriculture. Chemical perishing, as distinct from the destruction caused by micro-organisms, was investigated, and the conclusion arrived at is that the former type of perishing, which is by far the commoner, is due to hydrolysis of the cellulose molecules of the paper and their later decomposition into simple substances rather than to a process of oxidation. The type of paper found to be most resistant in India is a rag-paper the fibres of which have not been weakened in the process of manufacture. Treatment which has been found to damage the fibre is prolonged digestion with alkali, over-bleaching, non-removal of the last trace of bleach by antichlor, and imperfect washing that leaves traces of acid in the paper, while rosin and filling material should not exceed a small fixed percentage. It is recommended that all books and documents of permanent value should be removed to libraries in hill stations with temperate climates or placed in special buildings in which complete air control can be maintained.

SEVERAL distinctive features are embodied in a new model radioscopic couch by Messrs. Newton and Wright, Ltd. The tube-box, which is fitted with a holder to take a gas tube or Coolidge tube, is covered by sheet-lead and mounted upon steel rails, free movement being ensured by ball bearings. The diaphragm is of the rectangular type, and is operated by levers attached to a control arm; this latter projects horizontally from the tube-box, and is supported by one of two metal uprights which hold the protective apron in position. A further feature of interest is that these uprights allow the tube-carriage to be shifted longitudinally by the operator's knees, which should at times be found a great convenience. Protective devices figure conspicuously in this new model.

REMARKABLE developments have taken place in the use of water-power in many parts of the world during recent years, with which English engineers who have not time to consult foreign publications are unfamiliar, and in which English manufacturers have taken but little interest. The possibilities of development in this country and in other parts of the Empire of the sources of water-power are awakening an interest in the subject, and the proposed issue by Messrs. Henry Frowde, and Hodder and Stoughton, under the editorship of Prof. S. M. Dixon, of a quarterly *Journal of Hydraulics*, at an annual subscription of 31*s.* 6*d.*, each number of which will be self-contained and will make available in a convenient form details of the most recent developments of hydraulic engineering, should prove of interest and value to many engineers. A sufficient number of guaranteed subscribers is required before the first issue.

DR. ARNE WESTGREN has carried out some Röntgen spectrographic investigations of iron and steel in the University of Lund, Sweden, and presented his results at the May meeting of the Iron and Steel Institute. He has verified Hull's result that iron at ordinary temperatures (α iron) has a cube-centred cubic lattice structure, the edge of the unit cube being 2·87 Å. He finds that between 800° and 830° C.—that is, within the so-called β-iron range—the atoms are oriented in exactly the same way as in α iron, the edge of the unit cube being 2·92 Å. If allotrophy is accepted as being the same as polymorphy for solid crystalline bodies, this means that β iron cannot be considered as a separate modification. On the other hand, both in pure iron and in austenite at 1000° C.—that is, in the γ range—the crystals have face-centred cubic lattices, the edge of the unit cube being 3·61 Å. Consequently, this is characteristic of γ iron, and a fundamental crystallographic difference exists between α and γ iron. In martensite, the constituent of hardened carbon tool-steel, Dr. Westgren has found that the iron is in the α form. This is also the case in high-speed tool-steel hardened at 1275° C. The investigations are being continued, and will be extended to include complex phases in steel and other alloys. Spectrograms of cementite show that its crystal structure is related to that of γ iron, a fact which explains the mutual solubility of these phases.

LISTS Nos. 182 and 183 of the Cambridge and Paul Instrument Co., Ltd., give particulars respectively of the Cambridge microtomes and the Cambridge recording clinical thermometers. The firm now manufactures three types of microtomes. The universal microtome, on a circular cast-iron base of 250 mm. diameter, is constructed on similar principles to the Cambridge "rocker," but has a wider range of application; it cuts sections of 0·001 to 0·035 mm. in thickness from objects up to about 18 by 20 mm. in dia-

meter embedded in paraffin or celloidin. Since the object moves in a horizontal plane along the arc of a circle, it has the advantage that the sections are flat. The rocking microtome is similar in general construction to the instruments manufactured in previous years, but with improvements in details; it will cut sections 0·002 to 0·024 mm. in thickness from paraffin-embedded objects up to about 12 by 20 mm. in diameter. The freezing microtome has been specially designed for use in operation work. The thermometers, which give continuous automatic temperature records extending over a considerable period, are of the electrical resistance type, and consist essentially of a bulb containing a coil of platinum wire joined by connecting wires to a recorder. The record consists of a series of dots on the chart-paper, impressed every minute or half-minute as is desired.

Two correspondents have forwarded further suggestions for picture-hanging wire in reply to the letter under that title published in NATURE of May 19 last. The first relates to the use of single-strand enamelled phosphor-bronze wire of No. 18 B.W.G. This has been found satisfactory for pictures of moderate weight. The other method, similar to that described in NATURE of May 26, p. 395, is to use ordinary copper bell wire 0·055 in. to 0·02 in. in diameter. Pictures varying in weight from 1 lb. to 50 lb., using two wires for the heavier pictures, have been hung successfully with it. The need for straightening the wire carefully is emphasised in both letters, and the advisability of avoiding sharp bends at the edges of hooks is mentioned.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press a work, to be published in three parts, entitled "Dates and Date Cultivation in the 'Iraq," by V. H. W. Dowson, of the Agricultural Directorate of Mesopotamia. The three sections comprising the work will deal respectively with the cultivation of Basra date palms and the marketing of the fruit; statistics and details of the experiments from which the average yield of date gardens per acre is adduced; and the varieties of date palms found at Basra. Part iii., which will be illustrated, is promised for the coming autumn.

Our Astronomical Column.

PONS-WINNECKE'S COMET.—Mr. W. F. Denning writes:—"On May 28 this comet was conspicuously visible in a field-glass. The comet is at present situated in the Milky Way amongst the stars of Cygnus, and is moving to the south-east at the rate of about $3\frac{1}{2}°$ per day. It is increasing in apparent brightness, and may possibly come within naked-eye vision at the middle of June. The latest observations prove that the comet is farther from the earth than was expected, and that at perihelion it will be about 2,000,000 miles outside the terrestrial orbit. Perturbations by Jupiter in 1918 have altered the cometary path and lengthened the period of revolution. There may be a meteor shower on the nights from June 27 to 30, but the conditions are such that the display may not be a very brilliant one. Observations should be carefully made at the period mentioned, and it is fortunate that the evening sky will be free from moonlight."

SPECULATIONS ON THE FORMATION OF SPIRAL NEBULÆ.—M. Alex. Véronnet contributes an article on this subject to the *Comptes rendus* of the Paris Academy of Sciences for April 18. He examines the effect that would result from the impact of the two components of a binary system. He shows that the energy produced by friction at their surfaces is the most important factor, and that a mass equal to that of Jupiter might produce by impact with the sun a temporary increase of light amounting to twelve magnitudes. Radiation-pressure would then expel the heated particles with high speeds, and the revolutionary movement of the stars would give a spiral formation to the scattered particles. The author seeks thus to explain the phenomena both of novæ and of spiral nebulæ. He concludes that the latter would undergo a rapid evolutionary transformation (in the course of a few centuries). It would seem, however, that the larger spiral nebulæ are on too grand a scale to be the product of the impact of a mere pair of stars. The hypothesis is, however, worth considering in relation to such nebulæ as that which was revealed round Nova Persei by the light of the outburst, and Hubble's variable nebula in Monoceros.

M. Véronnet quotes the results obtained by Mr. Van Maanen, from photographs taken at intervals of several years, on the movements going on in certain nebulæ. These showed an outward tendency, agreeing with M. Véronnet's conclusions.

The nebula round Nova Persei had evidently been present, though unseen, before the outburst, and the suggestion had already been made that it might be the product of a former impact of the same two bodies that caused the outburst of 1901.

THE COMPANION OF α HERCULIS.—In the course of a paper on "Seven Spectroscopic Binaries" (*Astrophysical Journal*, April) Mr. R. F. Sanford announces that the fainter star of this well-known pair is a spectroscopic binary with a period of 51·6 days, only one spectrum being visible. He further announces that the radial velocity of the centre of gravity is −37·2 km./sec., whereas that of the principal star of the visual pair is −32·2 km./sec. Mr. Sanford concludes from this that the visual pair is only an optical one, the components not being physically connected. The following considerations, however, appear to show that this conclusion is unwarranted:—

The chance of two unconnected stars of magnitudes 3·5 and 5·5 being within 5″ of each other and having the same proper motion of 3″ per century in the same direction is so small as to be absolutely negligible. Moreover, the assumption of physical connection does not involve an unreasonable value of the masses. The spectroscopic parallax of component B is 0·018″ and the angular separation 4·7″, or 260 astronomical units (if unforeshortened); a joint mass equal to that of the sun would give a relative velocity in a circular orbit of 1·84 km./sec. The actual relative velocity is 5·0 in the line of sight and 1·6 at right angles, the position angle having altered by 6° in eighty years. The combined velocity is 5·25, giving a joint mass of $(5{\cdot}25/1{\cdot}84)^2$, or 8·14 times that of the sun. We know of many greater stellar masses; for example, in a paper by Herr P. Hügeler in *Astr. Nach.*, No. 5098, the masses of the components of ι Herculis are calculated to be 7·43 and 2·84 in terms of the sun.

Administration of Scientific Work.

LORD HALDANE presided at a meeting of the National Union of Scientific Workers held at University College, London, on May 30, at which Prof. L. Bairstow gave an address on "The Administration of Scientific Work."

Lord Haldane said that the occasion was most interesting to him, as he was presiding over a meeting of what bore a resemblance to a trade union. We were apt to forget that an organisation must have another purpose than merely the promotion of the interest of the individuals who belong to it. An organisation sometimes helped to keep standards high and shield the right, and that was one of the dominant aims of the National Union of Scientific Workers. The problem of how science and administration were to be related was a difficult one. Scientific men were often impatient of administration and the Treasury, but though these institutions hindered imaginative enterprise, he was not altogether sure the case was against them. Considering the expenditure now afforded on scientific research, we had little cause to lament the present period. The highest science did not allow itself to be organised, but it did not follow that for this reason there was to be no limit placed on expenditure.

Prof. Bairstow avowed as his ideal world one which was so administered as to ensure remuneration adequate for work, and thus secure in great abundance that desirable product, the work of the worker. Though most people would subscribe to that idea, it was the failure to work it out effectively that was responsible for most of our troubles. We lived in an age of "brain-waves," of disproportionate rewards for accidental discoveries, and the union was strongly opposed to such rewards. Scientific research was the foundation of progress; stop it, and industry would stagnate on the scientific side. Scientific ability should not be used up in applied research, which under existing conditions afforded more opportunities to the young and ambitious scientific worker than research at a university. University workers were under the perpetual shadow of financial anxieties, and could not, therefore, give their best work to instruction and research. The root of the problem was the resistance of the administrator to the idea of co-operation with the worker. Prof. Bairstow illustrated this point by reference to the programme for aeroplane construction prescribed in 1917 for the following year. Specifications for a number of types of machine were laid down without reference to the assistance of the technical *personnel* of the Air Board or of the aeronautical industry, with the result that manufacturers were unable to accept contracts on the basis of the specifications. The effect of this action was to denude the Department of its best technical men the moment the armistice was signed.

In proposing a vote of thanks to Prof. Bairstow, Sir Frank Baines congratulated him on the moderation he had shown, though he was convinced that under his reserve there was evidence of indignation against the position in which the scientific worker was placed to-day.

Dr. George Senter, in thanking Lord Haldane, ventured the opinion that only a short time would elapse before the whole nation would realise what scientific men realised already, the great value of the work he had done as the head of two Government Departments—work that was carried out in the true scientific spirit.

New Technical Applications of an Electrostatic Principle.

ON May 26 Messrs. A. Johnsen and K. Rahbek, two Danish engineers, gave a most interesting demonstration to the Institution of Electrical Engineers of new electrostatic microphones, telegraphic relays, etc., based on a little-known electrical phenomenon. If a smooth plate of brass is placed on a smoothly polished slab of lithographic stone about 1 in. in thickness resting on a conductor, and a potential difference of 400 volts is applied between the metal plate and the conductor, a strong attraction will be developed between the plate and the stone. Messrs. Johnsen and Rahbek demonstrated that the attraction between a metal disc about 2 in. in diameter and the stone was greater than 1 kg., although the current flowing was only a few micro-amperes. Provided the disc is in contact with the stone and the microscopic current is flowing, it lifts the stone as a magnet lifts its keeper. But when the current is broken the attractive force vanishes. The stone is a semi-conductor, but the voltage drop across the stone is very small compared with the voltage drop due to the resistance of the film between the brass plate and the stone. The force, therefore, is due to electrostatic attraction, which for a plate condenser varies inversely as the square of the distance between the plates.

This phenomenon has been utilised by the authors in the development of apparatus which will prove of great value in electrotechnics. Lithographic stone, slate, limestone, agate, flint, and many other semi-conductors can be used to show the electrostatic attraction. If the semi-conductor be rotating and a metal band slides on it, the friction between them will vary largely with the slightest variation of the microscopic current between them. As very appreciable mechanical forces are called into play, it is possible to utilise them in technical applications. In radio-telegraphy, for instance, it is useful as a thermionic recorder, the current from the ordinary small valves being amply sufficient to operate it at a speed of several hundred words per minute provided that at least 100 volts be used for the valves. Excellent records obtained in Copenhagen were shown of the messages sent out from the Eiffel Tower. As the recorder is free from self-induction, there is no practical limit to the speed at which records can be taken. If the metal band be connected to a sound-producing diaphragm and telephonic currents pass between it and the rotating semi-conductor, an extraordinarily loud-speaking telephone can be obtained. Using the body of a violin as the diaphragm, it was shown that the sounds produced by a violin played at a distance could be perfectly reproduced in the lecture theatre. Ordinary speech also was excellently reproduced and could be heard all over the room.

In connection with their inventions it is interesting to recall that Edison's first loud-speaking telephone depended for its action on electrostatic attraction. A chalk cylinder was rotated and a metallic spring pressed against it, a current passing between them. Sir William Barrett described this instrument to the Royal Dublin Society on January 19, 1880, and a summary of his lecture was given in NATURE (March 18, 1880, vol. xxi., p. 483). The electrostatic theory, however, was not then favoured. In 1905 Mr. Rollo Appleyard in a paper to the Physical Society described the adhesion which occurs between a metal plate and a dielectric when a very minute current passes between them. Electricians also have attributed to the effects of electrostatic attraction the alteration in the insulation resistance of paper condensers as the voltage varies.

Dalton and Atomic Symbols.

IN an article in the *Moniteur Scientifique Quesneville* Prof. Maurice Delacre, stimulated by a passage in "The Life and Work of Gerhardt" by E. Grimaux, severely criticises the attitude which was taken up by Berzelius in his celebrated "Essai sur la théorie des proportions chimiques" (Paris, 1819) towards the work of Dalton. The chief ground of the criticism is that in this work, the original of which appeared in Swedish in 1818, Berzelius describes his well-known system of chemical symbols without making any mention of the fact that Dalton had more than ten years previously introduced true atomic symbols and used them for the construction of formulæ. The passage in the "Essai" of Berzelius reads as though he himself had been the first to conceive this happy idea, and has thus given rise to the erroneous view entertained by some writers on the history of chemistry that Berzelius invented atomic symbols, whereas the credit is entirely due to Dalton.

Berzelius further, in the opinion of the author, exaggerated the importance of the work of Wenzel and Richter and minimised that of Dalton in connection with the discovery of the laws of chemical combination, whereas, in fact, these laws were clearly enunciated only after Dalton's ideas about atoms had become known. Prof. Delacre propounds the thesis that there is only one chemical law of weight, and this he proposes to call the "law of the symbol," regarding the laws of definite and multiple proportions as corollaries of this fundamental law.

There is here some confusion between experience and theory, and we do not regard this suggestion as judicious. It is, of course, true that Dalton's atomic theory has as necessary corollaries the laws of chemical combination, but the theory rests ultimately on the observations by which these laws were established, and to these observations it is undeniable that Wenzel and Richter made important contributions. In the matter of atomic symbols Dalton has, in this country at least and in most of the historical works with which we are acquainted, received full credit, and it is with surprise that we learn that some writers still erroneously attribute this important advance to Berzelius.

The Melbourne Meeting of the Australasian Association.[1]

II.

Abstracts of Presidential Addresses to Sections.

SECTION A (*Astronomy, Mathematics, and Physics*).—Prof. H. J. Priestley, of the University of Queensland, in his presidential address traced the development of the theory of relativity. In discussing the Einstein spectral-line effect, he pointed out that the usual treatment of the question involves the assumption that the time-period of the source is transmitted by the radiation to the observer. He gave reasons for making the alternative assumption that the Einstein interval *ds* is transmitted by the radiation, in which case the displacement of spectral lines should arise from a change in the field of the observer, not in that of the source. To meet the possible objection that the usual method of establishing the deviation of light in a gravitational field appears to imply an underlying constant time-period in the radiation, Prof. Priestley showed that the light path in a gravitational field could be found by a method which made no appeal to pre-relativity physics, and implied, therefore, no assumption as to the constancy of the time-period.

Section B (*Chemistry*).—Prof. N. T. M. Willsmore, in the course of his presidential address, referred to the indispensable work of British chemists during the war, stating that in the manufacture of explosives and in devising counter-measures against the enemy the chemist held the key to the position. Chemists were needed to deal with poison gas, to supervise water-supply, for the manufacture and use of artificial fog in the Navy, in the munition factories, and in numerous other spheres. In future wars chemistry would play an even greater part, and in the United States the Chemical Warfare Service had been organised as an independent branch of the Army. Prof. Willsmore then indicated the immense amount of work done by the chemists in the explosives and other factories in Great Britain.

Section C (*Geology and Mineralogy*).—"Recent Advances in our Knowledge of New Zealand Geology" was the title of the presidential address delivered by Prof. W. Noel Benson. The geological history of New Zealand was divided into three major periods, the oldest closing about Carboniferous times, the second in Lower Cretaceous times, and the third at the end of the Pliocene period. Comparative tables showing the classification of the strata in each period by many students of New Zealand geology illustrate the gradual evolution of the knowledge of New Zealand stratigraphy. It has been customary to consider the complex of gneisses and associated rocks in "Fiordland" as of Cambrian or pre-Cambrian age, but recent work by various investigators tends to show that this view is incorrect. Prof. Benson concludes that while some of the crystalline complex may be pre-Ordovician, the bulk of it is probably post-Ordovician, and some may be even of Mesozoic age. These rocks have been invaded by more or less gneissic plutonic rocks during a period of orogeny, followed either immediately or at a later orogenic period by massive plutonic intrusions. To the second period belong the "Maitai" (? Permian) and the "Hokonui" (Trias-Jurassic) systems. The relationship between the Hokonui series and the underlying Maitai series was discussed at length, and the conclusion reached that there is little evidence of a great unconformity, though crust-warping probably occurred. An interesting problem of New Zealand geology, the origin of the Otago schists, was also discussed. These rocks have been assigned to ages ranging from pre-Cambrian to Mesozoic. Prof. Benson suggested that they occurred as a series of sheet-folds, occasionally upturned and crushed, and composed for the most part of the metamorphic equivalents of Middle and Lower Triassic and Permian formations. The varying views as to periods of orogeny and plutonic intrusion and the general direction of folding were described and a new interpretation of the facts was suggested. Following the Hokonui orogenic movements, marine deposits were laid down, commencing with Middle Cretaceous and extending into Upper Pliocene beds. The diverse views of the relationship between these series were discussed and a complete bibliography of the literature was given. It was pointed out that during the deposition of these marine beds only in Otago is there evidence of a persistent land surface. The affinities of the fossil

[1] Continued from p. 410.

faunas and floras of New Zealand were then outlined and various views as to the existence of a land connection between New Zealand, Antarctica, Australia, and Malaysia were reviewed. The latter portion of the address dealt with igneous rocks from Cretaceous to more recent times and with the later orogenic movements and resultant physiographic features. In conclusion, Prof. Benson appealed for detailed investigations in New Zealand in all branches of geology.

Section D (*Biology*).—The president, Prof. A. J. Ewart, gave a summary of the work done in botany and geology during the war period, and pointed out that, large as it was, these sciences were not stimulated by war activity, as chemistry and physics were. With the increased productive activity now necessary to replace the waste of war, botany and geology would resume their original importance as the primary sciences connected with productive activity.

Section E (*Geography and History*).—"Geographical Problems of To-day and the Status of Geography in Science" was the subject of the presidential address delivered by Sir Douglas Mawson. He referred to the geographical changes brought about by the war. The war had put a temporary brake on geographic exploration and curtailed the study of geography at the universities, but it had been a great stimulus to map-making. Three recent events, each of which marked a stage in the geographical development of Australia, were the completion of the transcontinental railway, the first aerial link with Europe established by Sir Ross Smith, and the founding of an associate professorship in geography at Sydney University. It was gratifying to record the beginning of what might confidently be expected to be a more general recognition of geography as a definite science subject in Australasian universities. Such a movement would be greatly advanced by the existence of a vigorous geographical organisation in Australia. There was an unrivalled field for geographical inquiry in the Commonwealth, and under the stimulus of modern movement great things were to be expected. Even the coast-line of Australia was as yet only partly charted. Now that the Commonwealth had instituted its own Navy it had need also of organising an efficient hydrographic service to cope with this undertaking. In this a beginning had already been made, but to do justice to the Melanesian dependencies as well an extensive and well-founded organisation was needed. Fields for general exploration included parts of central and north-western Australia, Papua, and those territories for which Australia held mandates. Good geographical research could also be undertaken anywhere in Australia if investigators selected a definite area and worked it out in complete geographical detail.

Section F (*Ethnology and Anthropology*).—"Anthropology and the Government of Subject Races" was the title of the presidential address delivered by Mr. Justice Murray, Lieutenant-Governor of Papua. He pointed out that there were two methods of governing native races: (1) to abolish all native customs and institutions and introduce European substitutes, or (2) to use as an instrument of good government such customs as appeared to be useful, or even harmless. Anthropology was of service only with the latter, the "indirect" method, favoured by the British. Among savage races the different departments of thought and action were not clearly distinguished, as with us, and this must be borne in mind when dealing with them. Anthropology had so far not played an important part in administration. In the future, however, it was likely to become of the greatest help, either through the appointment of specialists or by encouraging the study among Government officers. The capacity of "thinking black or brown" required more sympathy and insight than the average man possessed, but it was very necessary, for there was always danger that natives would misconstrue some policy. The best remedy was the study of anthropology. It was partly to encourage this study among officers, and partly to assist the Government more directly, that arrangements were being made for the appointment of an officer as Government Anthropologist.

Section G (*Social and Statistical Science*).—Mr. G. H. Knibbs, Commonwealth Statistician, selected as the subject of his presidential address "World and Empire Development." Mr. Knibbs pointed out that the huge destruction of material wealth and the world-wide dislocation of economic relations had accentuated the importance of obtaining systematised statistics. This was recognised in the endeavour to establish a statistical branch for the League of Nations, as well as the International Institute of Statistics at The Hague and the International Institute of Agriculture at Rome. The rate of growth in the population of the white races which had characterised the last century was about 1 per cent. per annum, so that the population doubled itself in slightly under seventy years. Such a rate could not possibly continue, because of the limitations of food- and water-supply. Various materials, especially aluminium, were also being used up at a rate which was increasing more rapidly even than the population. Statesmen must perforce take account in the widest possible way of the rates of development and of exhaustion of supplies. The British Empire Trade Commission which visited Australia in 1913 realised that British business interests necessitated Imperial statistics, and it recommended a conference of the statisticians of the Empire. The conference recommended the establishment of a British Empire Bureau of Statistics, incorporated by Royal charter, the Prime Minister of the United Kingdom to be president in his capacity as *ex-officio* president of the Imperial Conference. The general aim was to facilitate the analysis of the drift of the past and to forecast the future position of the Empire. The falling-off of productive efficiency in Australia was an ominous fact for a young nation possessed of a valuable heritage and needing population for its development.

Section H (*Engineering and Architecture*).—In his presidential address on "The Present System of Education of Engineers and Architects" Mr. M. E. Kernot found grave faults in the education and training of men who were entering the profession. Experience with men who commenced at practical work and got into a groove often showed how much they might have done had they had the advantage of university training. With the system of articles results were also very variable; pupils who had completed their training in this way frequently showed themselves incapable of any design or construction work. The best hope for improvement in professional education lay in assuring university training to those fitted for it. Engineers recognised, too, that the community would be better served if more were made of the workman's brains and less of his muscle. The rough-and-ready estimating now in vogue should give place to scientific calculation.

Section I (*Sanitary Science and Hygiene*).—Taking as the subject of his presidential address "Accuracy in Medicine," Dr. J. H. L. Cumpston stated that two things were urgently necessary: (1) the education of the public to a proper conception of the need for accurate methods in medical diagnosis and treatment, and (2) the provision, within

practicable access of all medical practitioners, of the equipment necessary for the employment of these methods. Some form of common service must be provided so that each practitioner could have access either to the necessary instruments or apparatus or to some specialist who had the necessary knowledge and equipment. In the metropolitan areas such service was already largely provided by hospitals, specialists, and laboratories, but the provincial and country towns were at a disadvantage. The prevention of disease should be the first aim of medical science. The technical apparatus required for the application of many of the laws of public health was not unduly extensive, and could be made to serve large populations. There were enough trained medical men to make a commencement, and laboratories to serve all public health purposes should be forthwith established at all the principal country centres.

Section J (*Mental Science and Education*).—"The Need for the Scientific Study of Education" was the subject of Prof. A. Mackie's presidential address. He urged the need for a survey of the mental character of the school population for the effective practice of teaching and organisation, pointing out that the tests of general and scholastic intelligence devised by standard authorities must be re-standardised before they can be usefully employed for Australian children. The question of school examinations also stood in need of scientific investigation. The study of the errors made by pupils in the various branches of school-work might be expected to throw much light on the curative and preventive measures that should be adopted.

Section K (*Agriculture*).—That education should be general rather than special up to the age of fifteen was the plea of Prof. A. J. Perkins in his presidential address entitled "Agricultural Education." The bulk of those following agricultural pursuits were, in the main, home-trained, and the need for any other form of training was to some extent forced into the background. The State would do well to maintain agricultural colleges as half-way houses between the town and the country. Practical training in farming was of importance in conjunction with theoretical instruction, and the establishment of university training and chairs of agriculture must be backed up by the selection of adequate scientific staffs. Every effort should be made to overcome the effects of isolation of those engaged in agricultural pursuits. An extension of the agricultural bureau system of South Australia was advocated, under which agriculturists were grouped into local branches, where local interests were discussed and arrangements made for visits of experts and experimental work.

Section L (*Veterinary Science*).—The president, Prof. H. A. Woodruff, delivered an address on "The Development of the Present Conception of Immunity."

At a joint discussion (Sections A and B) on "The Applications of Physical and Chemical Science in the Great War" Mr. A. E. Leighton (Director of the Commonwealth Arsenal) gave a brief sketch of two war activities on the part of applied chemistry and the particular significance they held for Australia. These were the important factors of cordite and high explosive. It must be remembered, said Mr. Leighton, that Australia was not in a fortunate position as a manufacturing country, and her provision against attack must take the form of finished munitions. Until the industries of Australia were in a position to maintain a flow of munitions commensurate with requirements, they must adhere to the policy of importing and holding stocks. Australia had illimitable quantities of iron-ore, but what the munition-worker wanted was steel rolled to a certain shape. He wanted caustic soda and chlorine. The tariff and recent legislation had given promises that the Ministry intended to encourage supply. But to become a manufacturing community was a slow and costly process. Protection should be scientific in the sense that in protecting the industry the people should also be protected from rule-of-thumb methods. The number of chemists and engineers should be increased, for without them the illimitable resources of the country could not be treated.

Dr. A. C. D. Rivett particularly directed attention to the lesson already learned by Germany and England, that the possession of flourishing chemical industries was not merely a means to material prosperity in times of peace, but also absolutely essential as an instrument of warfare. Men in Australia had to realise that to build up the chemical manufactures of Japan or America, or any other country, and to neglect their own, was precisely the same as building up other armies and navies while forming none of their own. Dr. Rivett urged the adoption of the following motion:—"That these sections of the Australasian Association for the Advancement of Science, recognising the vast importance of chemical science in modern warfare, recommend that the general council urge upon the Federal Ministry the necessity for fostering chemical industries in Australia under such conditions as will ensure the maximum readiness for the production of munitions of war in case of need." The motion was seconded by Prof. Orme Masson, and agreed to unanimously.

Prof. T. H. Laby read a paper on "The Organisation of Science in Australia." Prof. Laby pointed out that, although during the war period science had been applied most successfully to assist in the exploitation of Nature's resources for our material benefit, a greater achievement would be to instil into the national mind the high ideals which have actuated so many men of science. This would be assisted by a re-organisation of science such as had been undertaken by Great Britain, the United States, and Japan. The lack of any single Australian scientific society was also commented on, the political control exercised over the Commonwealth Institute of Science and Industry was criticised, and the position of the mathematical and physical sciences in Australia was indicated as illustrative of the need for organisation. In conclusion, the author urged the formation of an Australian scientific society representative of all research workers in science in Australia, which would be able to act in an advisory capacity to the Commonwealth Government upon scientific matters. This plea has now been answered to a large extent by the formation of the National Research Council referred to last week.

Numerous papers were read to the various sections and a number of joint discussions on problems common to more than one section were held. Especially is the association to be congratulated on the formation of a National Research Council, which should prove a real asset for the advancement of science in Australia.

University and Educational Intelligence.

BRISTOL.—Sir Isambard Owen, vice-chancellor of the University, is to retire at the end of the present session, having reached the age limit of seventy years prescribed by the rules of the Treasury with regard to superannuation.

LONDON.—Dr. R. R. Gates has been appointed to the University chair of botany tenable at King's Col-

lege in succession to Prof. W. B. Bottomley. He was appointed University reader in botany at that college in 1919, and has since that date been in charge of the department in the absence of Prof. Bottomley.

Mr. D. M. S. Watson has been appointed as from August 1 next to the Jodrell chair of zoology and comparative anatomy at University College in succession to Dr. J. P. Hill, now professor of embryology. Since 1912 Mr. Watson has been lecturer in vertebrate palæontology at that college. He has also lectured in the Universities of Munich, Cape Town, Sydney, California, Michigan, and Chicago.

Mr. H. G. Jackson has been appointed as from August 1 next to the University readership in zoology tenable at Birkbeck College. In 1912 Mr. Jackson was appointed research assistant to Prof. Herdman at the University of Liverpool, and since 1913 has been lecturer in zoology at the University of Birmingham.

Dr. William Wilson has been appointed as from September 1 next to the University chair of physics tenable at Bedford College. Since 1919 Dr. Wilson has been senior lecturer in physics at King's College, and in 1920 he received the title of reader in physics.

The following doctorates have been conferred:—*D.Sc. in Botany:* Mr. F. G. Gregory, an internal student of the Imperial College—Royal College of Science, for a thesis entitled "The Increase in Area of Leaves and Leaf-surface of *Cucumis sativus*." *D.Sc. in Chemistry:* Mr. H. Yaroslav, an internal student of University College, for a thesis entitled "The Electro-affinity of Aluminium." *D.Sc. in Zoology:* Mr. L. T. Hogben, an external student, for a thesis entitled "Studies on Synapsis." *D.Sc. (Engineering):* Mr. F. E. Rowett, an external student, for a thesis entitled "The Resistance to the Flow of Oils through Rubber and Steel Pipes," and other papers.

Mr. L. H. Dudley Buxton has been elected to an Albert Kahn travelling fellowship for the year 1921–22. These fellowships, which are now of the value of 1000*l.* each, were founded in 1910 by Mr. Albert Kahn, of Paris, to enable the fellows to travel for at least one year in foreign countries, so that by the study and comparison of national manners and customs, and of political, social, religious, and economic institutions, they may become better qualified to instruct and educate their fellow-countrymen.

DR. A. G. GIBSON, lecturer in morbid anatomy in the University of Oxford, is to deliver the Schorstein memorial lecture at 4 o'clock on Friday, June 3, at the London Hospital Medical College. The subject will be "Chronic Inflammatory Diseases of the Spleen."

THE summer meeting of the Association of Science Teachers will be held at Cambridge on Saturday, July 9. There will be a short business meeting in the morning at Girton College (by kind permission of the Mistress of Girton), where members will have lunch. In the afternoon Dr. F. W. Aston will give a lecture on "Atoms and Isotopes."

Two research scholarships of the annual value respectively of 100*l.* and 75*l.* are being offered by the Huddersfield Technical College, the object being the encouragement of research upon problems connected with the coal-tar industry in Great Britain. Further information can be obtained from Dr. H. H. Hodgson, Colour Chemistry Department, Technical College, Huddersfield.

Two lectures entitled "The History of Map-making" and "Maps of the Principal Voyages of the Sixteenth Century" are being delivered at 7 p.m. on Mondays at Birkbeck College (University of London), the first on Monday last and the second on June 6, by Mr. W. H. Barker. In connection with these lectures there is being held an exhibition of maps, charts, and globes illustrating the history of map-making and geographical discovery. Admission to the lectures is free without ticket.

RESEARCH scholarships in agricultural and veterinary science (not more than five in number), each of the annual value of 200*l.* and tenable for two years, are being offered by the Ministry of Agriculture and Fisheries. The agricultural scholarships are open to graduates with honours in science of a British university. The veterinary scholarships are open to students who have secured the diploma of the Royal College of Veterinary Surgeons. Nominations on the prescribed form must reach the Secretary, Ministry of Agriculture and Fisheries, 4 Whitehall Place, S.W.1, by, at latest, July 15 next.

THE University of the West at Bristol, of which Lord Haldane is the Chancellor, has issued a striking illustrated appeal for the sum of 1,000,000*l.* for endowments and maintenance. The appeal takes the form of a series of thirty delightfully executed and printed folio drawings, not only of existing buildings connected with the University in Bristol and in its neighbourhood, but also of buildings in the course of erection on an admirable and unencumbered site of 13½ acres near the centre of the city, which are due to the munificence of the late Mr. H. O. Wills and his sons, Messrs. G. A. and H. H. Wills. The appeal is accompanied by a sheet of three remarkable cartoons by Mr. Louis Raemaekers illustrating the need for the more complete education of the youth of the nation, both men and women, who did it such splendid service in the eventful years 1914–18. Under the cartoons are respectively the remarkable, but true, words: "Genius is not drawn from any exclusive class or caste, but from the cradles of the nation; no longer can we afford to waste the development of ability if we are to maintain leadership." "It is the universities which train; it is in them that the fullness of knowledge dwells." "They look forward to an era of research, experiment, discovery, invention, and intellectual progress that shall surpass even the record of the century that is past." Not only are efficient buildings and equipment essential, but even more so are opportunities of free development unhampered by bureaucratic regulations, and of adequate maintenance for teachers and their satisfactory superannuation, whilst the provision of numerous maintenance scholarships is a necessity if the able children of the working community are to enjoy the advantage of a university education. No difficulty should be found in raising the funds necessary to ensure adequate support for the universities now so urgently appealing for funds in various parts of the country if only the wealthy members of society and the various local authorities within their respective areas would realise their responsibilities. There has arisen a great demand of late throughout England for the more complete provision of continued and higher education, and if this demand is to be met it is essential that the universities from which the chief inspiration should be derived shall be maintained in the fullest efficiency of means and methods.

Calendar of Scientific Pioneers.

June 2, 1886. James Apjohn died.—A lecturer and professor of chemistry at Dublin for more than fifty years and a vice-president of the Royal Irish Academy, Apjohn wrote on chemistry, mineralogy, and meteorology, and his name is connected with a formula for ascertaining the dew-point.

June 2, 1901. John Viriamu Jones died.—After a distinguished career at Oxford, Jones in 1881, at the age of twenty-five, became principal of Firth College, Sheffield, and two years later was made the first Principal of University College, South Wales. His principal scientific work referred to accurate determinations of electrical and physical standards.

June 2, 1903. Andrew Ainslie Common died.—An engineer by profession, Common devoted himself to the construction of large reflecting telescopes with silver-on-glass mirrors. Harvard and Lick Observatories possess instruments from his Ealing workshops. He received the gold medal of the Royal Astronomical Society for his photographs of the great nebula in Orion, and in 1895–96 was president of the society.

June 3, 1657. William Harvey died.—Born at Folkestone on April 1, 1578, Harvey was educated at Canterbury, Cambridge, and Padua, and, after graduating in medicine, settled in London. Appointed physician to St. Bartholomew's Hospital in 1609, six years later he became Lumleian lecturer at the College of Physicians, where he first publicly taught the doctrine of the circulation of the blood. His celebrated treatise, "Exercitatio Anatomica de Motu Cordis et Sanguinis," was published at Frankfort in 1628. He was physician to James I. and Charles I. His tomb is at Hempstead, near Saffron Walden.

June 3, 1822. René Just Haüy died.—After many early privations, Haüy became a teacher in the College of Navarre in Paris. An accident to a crystal of calcareous spar led him to the discovery of the law of crystallisation. His first memoir on the structure of crystals appeared in 1784. He afterwards held important official positions, among which was the chair of mineralogy at the Jardin des Plantes.

June 5, 1716. Roger Cotes died.—In 1706, at the age of twenty-four, Cotes became the first Plumian professor of astronomy and natural philosophy at Cambridge. He assisted Newton in the revision of the "Principia," with Whiston gave one of the earliest courses of experimental philosophy, and in Trinity College erected an observatory. A man of exceptional genius, Newton, referring to his work on optics, remarked: "If Mr. Cotes had lived we should have known something."

June 7, 1826. Joseph von Fraunhofer died.—A glass-cutter's apprentice, Fraunhofer in 1804 became associated with Reichenbach, the instrument-maker. A skilful maker of telescopes, he invented the stage micrometer, the diffraction grating, and a form of heliometer. He discovered the dark lines in the spectrum previously seen by Wollaston, and laid the foundations of solar and stellar chemistry.

June 8, 1695. Christiaan Huygens van Zuylichem died.—The greatest of Dutch physicists, Huygens is a connecting link between Galileo and Newton. Born at The Hague in 1629, he spent many years of his life in Paris. He improved the telescope, discovered the first of Saturn's satellites, explained the nature of Saturn's ring, adapted the pendulum to clocks, and advocated the undulatory theory of light. His principal works were his "Traité de la lumière" and his "Horologium Oscillatorum." He is buried in St. Peter's, Leyden. E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 26.—Prof. C. S. Sherrington, president, in the chair.—Sir Alfred **Ewing**: The atomic process in ferro-magnetic induction. The author's modification of Weber's theory of magnetisation is reconsidered in the light of (1) modern views regarding the structure of the atom and (2) the X-ray analysis of crystal structure. The rotatable Weber magnet seems to be an attribute of the atom, probably an electron system within it. Metallic iron is now known to be an aggregate of crystals, in each of which the space-lattice is the centred cube, with its atoms most closely grouped along the trigonal axes. It is along these axes that the Weber elements will point. Consequently an iron crystal is not magnetically isotropic. The small quasi-elastic or reversible part preceding the much larger changes which involve hysteresis corresponds to a reversible deflection of the Weber magnets through a small angle, generally of an order of 1°. The theory of the equilibrium of a row of magnets is considered. Experiments in which rows of Robison magnets with ball ends have their equilibrium upset by an extraneous field confirm the theory. The field which would break up rows of magnets set in the space-lattice close enough together to bring the reversible deflection within the above limit is calculated; it is larger than the field that suffices to produce strong magnetisation in iron, suggesting that the ordinary laws of force between magnetic elements cease to apply at interatomic distances.—C. D. **Ellis**: The magnetic spectrum of the β-rays excited by the γ-rays. The magnetic spectra of the β-rays ejected from various elements by the γ-rays of radium B have been examined by the focussing method. The positions of three strong lines occurring in the magnetic spectrum of radium B depend on the metal target used. Assuming that each of these three lines is due to a definite γ-radiation, it is shown that the energy of the β-rays forming a line is equal to an energy characteristic of the γ-radiation *minus* the work necessary to remove an electron from the K ring of the atom. By application of the quantum theory the frequency of the γ-rays can be determined from these characteristic energies. The natural β-ray spectrum of radium B can be explained in this way, the stronger lines resulting from the conversion of the γ-rays in the K ring, and the weaker lines from a similar conversion of the same γ-rays in the L ring.—S. **Datta**: The spectra of the alkaline earth fluorides and their relation to each other. A survey of the spectra of these compounds has been made and several new bands observed. These helped in the identification of homologous series of bands in the different spectra, and have suggested an empirical relation amongst them, based on the constants of the series equations and the molecular weight or the molecular number of the respective compounds. Starting with the series equation of the band-heads, an explanation has been given of the appearance of a "tail" in some of the bands. It has been shown that the frequency of the "tail" is a maximum or a minimum, and that the difference in wave-numbers of the heads and tails of the similar series is constant for the same compound, but varies from one another in a definite way.—Dr. W. L. **Balls**: A simple apparatus for approximate harmonic analysis and for periodicity measurements. The error involved in the use of this apparatus need not exceed 3 per cent. Its outstanding advantage is the speed with which determinations may be made. Thus in determinations of periodicity some fifty trial periods can be examined in less time than is required for the

computation of a single trial period under the periodogram arithmetical method.—Dr. G. R. **Goldsbrough**: The influence of satellites upon the form of Saturn's ring. The ring is supposed to be made up of small particles arranged in concentric circles and rotating about the primary. The satellite is assumed to follow an unperturbed circular orbit, and the influence of the rings upon one another is assumed negligible. To a close degree of numerical approximation the satellite Mimas is responsible for the position and width of Cassini's Division and for the clean-cut termination of the whole ring. Satellite Rhea accounts for the clean-cut commencement of the inner ring (or ring B), while a probable explanation is offered of the existence of the crêpe ring. If m be the mass of any particle, and M the mass of Saturn, and n the number of particles in any single ring, it is shown that

$$O<m/M<1{\cdot}8/n^3.$$

The maximum mass of a particle is thus just below the limit given by Maxwell.—Dr. H. **Jeffreys**: Certain geological effects of the cooling of the earth. Mechanical consequences of the cooling of the earth from its formation to its present state are considered. The former fluidity of the earth is assumed and the information provided by radio-activity is utilised. The thermal contraction available for mountain-building is of the same order as that required to account for existing mountains. The Pacific type of mountain range can be explained as due to greater cooling and consequent greater strength of the rocks below the ocean. Isostatic compensation of surface inequalities is due to variation in the thickness of the light rocks constituting the crust, combined with plastic flow below. The fact that oceans have extensive regions of less depth in the middle is explained and theories of the formation of continents and geosynclines are suggested.—T. **Kikuchi**: The moving striations in a neon tube.

Geological Society, May 4.—Mr. R. D. Oldham, president, in the chair.—H. Hamshaw **Thomas**: An Ottokaria-like plant from South Africa. The discovery in the Vereeniging Sandstones of the Transvaal of a fossil plant which bears considerable resemblance to the genus Ottokaria is recorded. The specimen agrees with known examples in size, and in having an almost circular head seated upon a stalk; an additional feature is a thin flattened structure projecting beyond the head, provisionally called the "wing." Ottokaria was probably a reproductive structure, and its association with Glossopteris suggests a possible connection with this plant. The name of *Ottokaria Lesliei* is assigned to the specimen.—Dr. A. B. **Walkom**: On Nummulospermum, gen. nov., the probable megasporangium of Glossopteris. Seeds associated with some fronds of Glossopteris from Queensland are described under the name *Nummulospermum bowenense*. The vascular system is also partly described. The seeds have not been found in actual connection with Glossopteris fronds. Remarks are added on the scale-leaves of Glossopteris, and on the affinities of Glossopteris, which is classed with the Cycadofilicales. The anatomical features of the seeds suggest relationship with the Trigonocarpales.—Agnes **McDonald** and Dr. A. E. **Trueman**: The evolution of certain Liassic gastropods, with special reference to their use in stratigraphy. The gastropods dealt with are turriculate forms, formerly called Cerithium, now referred to the family Procerithidæ, Cossmann, and Chemnitzia, now referred to the family Loxonematidæ, Koken. Suggestions for the classification of these gastropods, based on ontogenetic and other evidence, are made. The position and characters of the ornamentation have proved of value in classification, when taken in conjunction with the other characters of the shell. In numerous series acceleration or retardation of development is indicated, and examples of homœomorphy of several types have been noted. The Procerithidæ of the Lower Lias are chiefly species of Procerithium, in which the flattish whorls have reticulate ornament based on three spirals. This series probably gave rise to many recent Cerithidæ which have more than four spirals. Other genera of Procerithidæ are recognised. The pupoid forms which have been grouped in the genus Exelissa are regarded as catagenetic descendants of diverse species of Procerithium. The Loxonematidæ of the British Lias are of two types, one with axial ornament (Zygopleura), the other with axials and feeble spirals (Katosira). Each of these genera shows during the Lias an increase in the number and curve of the axials. In development axials always appear before spirals among the Loxonematidæ, while spirals are developed first among the Procerithidæ.

Physical Society, May 13.—Sir William Bragg, president, in the chair.—L. **Hartshorn** and E. S. **Keeping**: Notes on vacuum tubes used as detectors of electrical oscillations. The paper describes the development of a robust form of vacuum tube which was used as a detector of electrical oscillations in the "wireless" circuits carried by aeroplanes. Platinum electrodes are avoided, being replaced by strips of tinfoil, to which contact may be made by the spring clips holding the tube in position. It was found that when a discharge is passed through such a tube the walls are affected in such a way that thenceforth it is much easier to get a discharge to pass. The change produced by the first discharge is annulled by heating the tube above 210° C. Further, if the walls are coated on the inside with a metallic film, this first discharge is unnecessary, and the tube is unaffected by heating, but when the walls are coated with an insulator it is, if anything, more difficult to pass a discharge. A silica tube behaves like one coated with metal. It seems possible that the change in the tube may be due to the formation of a layer of gas molecules on the walls by the first discharge. The explanation of the behaviour of the silica tube is a difficulty.—B. W. **Clack**: The coefficient of diffusion of certain saturated solutions. This paper gives an account of experiments on the diffusivity of saturated solutions of KCl, NaCl, and KNO_3 at constant temperatures near 18° C., when the steady state of diffusion has been attained, employing a method similar to that previously used by the author (Proc. Phys. Soc., vol. xxi., p. 863, 1908; vol. xxiv., p. 40, 1911; vol. xxvii., p. 56, 1914; vol. xxix., p. 49, 1916). The solution under investigation is maintained at complete saturation by the presence of salt crystals in the diffusion vessel; the theory takes into account the change in volume of this salt as it dissolves, and an expression is obtained for the coefficient of diffusion at complete saturation, which depends on the rate of change in weight of the diffusion vessel with time. The experimental results are found to agree very closely with the values obtained by extrapolation from the results previously found for less concentrated solutions. By the present paper the author has thus extended the range of concentration over which he has studied diffusion from very dilute solutions right up to complete saturation.—Dr. G. D. **West**: Experiments on thermal transpiration currents. Theoretical considerations are first introduced to show that if a radial temperature gradient be maintained over a disc so that the centre is the hottest part, thermal transpiration currents sweep radially inwards over the surface of the disc, and discharge themselves more or less radially outwards in the upper regions. To detect

these currents a narrow strip of foil is used which is placed perpendicular to the disc and to one side of the hot region. When at a considerable perpendicular distance from the disc, and when the gas pressure is sufficiently low to eliminate convection currents, the deflections of the strip of foil are always away from the hot region. When, however, the strip is placed very close to the disc its deflections over a certain range of gas pressure are towards the hot region. These facts are explained by the tendency of the thermal transpiration currents to drag the strip with them. The paper emphasises one of the essential differences between thermal transpiration currents and convection currents, namely, that while the latter clearly depend on gravitation, the former do not.

CAMBRIDGE.

Philosophical Society, May 2.—Prof. A. C. Seward, president, in the chair.—E. K. **Rideal**: Active molecules in physical and chemical reactions. The chemical nature of evaporation is established by the calculation of heats of reaction from spectral data with the aid of the quantum theory. Evaporation is regarded as a monomolecular chemical change; equating the rate of evaporation to the rate of condensation when equilibrium is attained, the unknown integration constants of the Clapeyron-Clausius equation, and thus the chemical constants of Nernst, have been determined. The values obtained agree closely with those experimentally derived. The energy of activation is probably an average value representing the mean energy of activation of a gram-molecule of reactant, and a formula from which it can be calculated is given. The hypothesis receives support from the fact that at the critical temperature the radiation intensity is at a maximum for light of the particular frequency with which the active molecules are in equilibrium. Wien's law $\lambda_m T = \text{constant} = 0{\cdot}28986$ is shown to be a simple variant of Trouton's rule $L = KT_c$. The value of K as calculated from the purely radiation-derived data of Wien is found to be 9·866. The latent heats of evaporation calculated from Wien's law are found for non-associating liquids to agree very closely with those derived from vapour-pressure data. The equilibrium of the active molecules with the radiation may be ascribed to resonance.—Dr. **Hartridge**: (1) An experiment which favours the resonance theory of hearing. When the phase of a musical note is suddenly altered by π the note fades momentarily to silence, and returns a moment later to its former intensity. (2) A criticism of Wrightson's theory of hearing. A mathematical analysis is advanced to demonstrate the existence of the coincidences required by the theory between the lengths of the periodically repeated time-intervals in the separate tones and those present when all the tones are sounding together. They are found to be imaginary. (3) A method of projecting interference bands. If a celluloid replica diffraction grating be mounted in optical contact with a polished metal surface, and a beam of approximately monochromatic light be projected into it, the spectra produced are crossed by interference bands. (4) A method of projecting absorption spectra. If a celluloid replica diffraction grating be mounted on the hypotenuse of a right-angled glass prism, with the rulings parallel to the apex, and a beam of approximately parallel light be caused to enter along the normal to the base, a spectrum of wide dispersion and great intensity is produced. (5) The shift of absorption bands with change of temperature. The absorption bands of blood pigment in the visual region of the spectrum have been observed at the temperature of evaporation of liquid air and liquid nitrous oxide by drying films of a solution of the pigment in gelatine on glass slabs and then immersing them in the cold liquids. It is found that such films retain their transparency. The reversion spectroscope shows that both α- and β-bands are sharper at low temperatures, and that they are displaced towards the violet end of the spectrum approximately 41 Å. The change in wave-length cannot be due to change in refractive index of the solvent, because dissolving blood pigment in glycerine instead of in water leaves the band unchanged.—Dr. H. S. **Carslaw**: The cooling of a solid sphere with a concentric core of a different material. The method used is to study the contour integrals over a certain standard path. Estimates of the age of the earth founded upon the present surface temperature gradient are discussed.—C. R. G. **Cosens**: An alignment chart for thermodynamical problems.—Dr. T. J. I'A. **Bromwich**: Symbolical methods in the theory of conduction of heat.—C. V. **Hanumanta Rao**: A property of focal conics and of bicircular quartics.

DUBLIN.

Royal Dublin Society, April 26.—Dr. F. E. Hackett in the chair.—J. **Davidson**: Biological studies of *Aphis rumicis*.—H. G. **Becker**: A new principle in blow-pipe construction. The essential features of a quick-change blow-pipe to operate with air at constant pressure, such as is supplied by a blower driven by power, are discussed and the necessity for air-jets of different bore for the different flames is emphasised. The tubular shape common to all hitherto existing blow-pipes is shown to be unnecessarily cumbersome, and is therefore abandoned. A form of blow-pipe giving a great range of flames (including a flat blow-pipe flame), each provided with an air-jet of suitable size and allowing of instantaneous change from one to the other, was described, and an actual blow-pipe constructed on this principle was shown in operation.

PARIS.

Academy of Sciences, May 9.—M. Georges Lemoine in the chair.—F. **Widal**, P. **Abrami**, and J. **Hutinel**: Comparative researches on the working of the liver following surgical anæsthesia produced by chloroform, ether, nitrous oxide, or novocaine. It has been shown in previous communications that slight functional alterations in the liver can be detected by simple leucocyte counts, after absorption of a glass of milk. The method has been applied to the study of the functional derangements of the liver produced by anæsthetics. Chloroform, ether, and nitrous oxide produced derangements of function, chloroform acting most powerfully. Injections of novocaine were without effect on the liver.—M. Georges Urbain was elected a member of the section of chemistry in succession to the late M. Emile Bourquelot.—F. **Vaney**: The polynomials of Laguerre.—A. **Angelesco**: A representation of polynomials by integrals.—R. **Birkeland**: The convergence of the developments which express the roots of the general algebraic equation by a sum of hypergeometric functions of several variables.—B. **Gambier**: Real non-unicursal algebraic curves with constant torsion.—M. **Idrac**: Experimental studies on hovering flight. In an earlier note the opinion was expressed that wherever birds are hovering in stationary flight they are always in a zone where the wind has a vertical ascending component. Results confirming this view are now given, and records of the variations in temperature and pressure of the air taken on apparatus carried by captive balloons are reproduced.—J. **Vallot**: Study of the diffuse radiation of the sky compared with the direct solar radiation. The total diffuse radiation is considerable, and may amount to one-third of the solar radiation.—A. **Leduc**: A new equation of state for gases based on a know-

ledge of the internal pressures.—H. **Abraham** and R. **Planiol**: The use of the Baudot telegraph in wireless telegraphy. The Baudot quadruple instrument used in the ordinary way records 7200 words per hour. A description of the adaptation of this to wireless transmission is given. The first experiments were made across Paris; later the apparatus was successfully used between Paris and Nogent-le-Rotrou.—M. St. **Procopiu**: Electrical double refraction of mixed liquids and crystalline structure.—A. E. **Lindh**: The absorption spectra of chlorine for the X-rays. All chlorides in which the chlorine is monovalent have similar X-ray spectra, but there is a displacement of the limits of absorption in $KClO_3$ and $KClO_4$, compounds in which the valencies are 5 and 7.—D. **Coster**: The principle of combination and the law of Stokes in the X-ray series.—MM. M. **Menard** and **Pestel**: Concerning the danger of radiological installations. The authors conclude that, provided the usual precautions required for the safety of the operator are taken, there is no real danger to third parties in neighbouring rooms.—A. **Tian**: A theory of the slow hydrolysis of salts.—MM. P. **Jolibois** and **Bouvier**: The reversibility of the reaction $CaCO_3 = CO_2 + CaO$. The self-recording apparatus described in an earlier paper has been applied to the study of the dissociation of calcium carbonate. The heating and cooling curves are not the same, and hence the reaction is not strictly reversible.—G. **Dupont**: Contribution to the study of the acid constituents of the exudation of the maritime pine. The composition of pimaric acid. Pimaric acid purified by Vesterberg's method is a mixture of 37 per cent. of dextropimaric acid and 63 per cent. of the lævo-acid.—L. **Longchambon**: The measurement of the rotatory power in biaxial crystals.—L. **Cayeux**: The petrographic *rôle* of fossil Alcyonaria deduced from the analysis of the Jurassic iron minerals of France.—L. **Joleaud**: A deep boring which demonstrates the existence of transported strata in northern Tunis. A trial boring for oil made at Aïn-Rhelal started in the Middle Miocene, then passed through the Trias (630 metres), and finally met with strata undoubtedly belonging to the Upper Cretaceous.—F. **Ehrmann**: The Trias of the Kabylie des Babors (Algeria).—J. **Beauverie**: The resistance of mitochondria and plasts, and relations with attacks by parasites.—G. **Mangenot**: The structure of the antherozoids of the Fucaceæ.—R. **Lance**: The use of coloured screens for fighting against cryptogamic diseases of plants. The plants are sprayed with solutions containing blue, green, and violet dye. The fluid dries and leaves the parts of the plant covered with a colour screen allowing blue, violet, and ultra-violet light to pass. No results of the treatment are given.—R. **Lance**: An anticryptogamic product. A proposal to use salts of zinc for spraying plants.—M. **Mirande**: Seeds giving hydrogen sulphide by fermentation belonging to the family of the Papilionaceæ. Many leguminous seeds, including beans, peas, and lentils, when moistened with water undergo a spontaneous fermentation, one of the products of which (sulphuretted hydrogen) is poisonous.—C. **Champy**: The experimental change of sex in *Triton alpestris*. A male, subjected to starvation, had its testicle replaced by a fatty band containing neither spermatocytes nor spermatozoids. Two animals after winter starvation were intensively fed. The external colouring changed from male to female in character. One of these was killed, and showed the adipose band; the second, killed two months later, showed a genital gland (section shown in diagram) corresponding to the ovary of a young female.—L. **Roule** and F. **Angel**: Fishes of the family of the Diretmideæ and their place in classification.—A. **Gruvel**: The geographical distribution of some Madagascan lobsters and their commercial exploitation.—J. **Dragoiu** and F. **Vlès**: The cytological consequences of the osmotic arrest of cell division. The increase of the external osmotic pressure first retards, then stops, the division of the cytoplasm. With additional increase of osmotic pressure the internal evolution of the cell is progressively changed in a regular manner. The whole process simulates a kind of regression of nuclear evolution.—M. **Doyon**: The use of chloroform for the preparation of nucleo-proteids and nucleic acids active *in vitro* on the blood. The complexity of the action of the nucleic acids *in vitro*.—M. **Bordier**: The usefulness of diathermal d'Arsonvalisation in atonic wounds.

Books Received.

The Works of Aristotle. Translated into English under the editorship of W. D. Ross. Vol. x.: Politica. By Benjamin Jowett. Oeconomica. By E. S. Forster. Atheniensium Respublica. By Sir Frederic G. Kenyon. Unpaged. (Oxford: Clarendon Press.) 15*s*. net.

Insects and Human Welfare. By Prof. Charles T. Brues. Pp. xii+104. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press.) 10*s*. 6*d*. net.

Fugitive Essays. By Josiah Royce. Pp. 429. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press.) 17*s*. net.

Aeroplane Performance Calculations. By Harris Booth. (The D.-U. Technical Series.) Pp. xv+207. (London: Chapman and Hall, Ltd.) 21*s*. net.

Landscape Gardening. By Andrew J. Downing. Tenth edition, revised by Frank A. Waugh. Pp. xv+439. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 36*s*. net.

The Study of Geological Maps. By Dr. Gertrude L. Elles. (Cambridge Geological Series.) Pp. viii+74+vii plates. (Cambridge: At the University Press.) 12*s*. net.

The Journal of the Royal Anthropological Institute. Vol. 1., 1920, July–December. Pp. x+237–465+12+plates. (London: Royal Anthropological Institute.) 15*s*. net.

The Relative Value of the Processes Causing Evolution. By Dr. A. L. Hagedoorn and A. C. Hagedoorn-Vorstheuvel la Brand. Pp. v+294. (The Hague: M. Nijhoff.) 9 gld.s.

The Reign of Relativity. By Viscount Haldane. Pp. xxiii+430. (London: J. Murray.) 21*s*. net.

Memoirs of the Geological Survey: England and Wales. The Water Supply of Buckinghamshire and of Hertfordshire from Underground Sources. By W. Whitaker. Pp. iv+368. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 16*s*. net.

The Banana: Its Cultivation, Distribution, and Commercial Uses. By William Fawcett. Second and enlarged edition. Pp. xi+299. (London: Duckworth and Co.) 15*s*. net.

Diary of Societies.

THURSDAY, JUNE 2.

INDUSTRIAL WELFARE SOCIETY (at 51 Palace Street, S.W.1), at 10.30.—Dr. R. M. Wilson: Medical Service in Industry.—Prof. E. L. Collis, Dr. T. M. Legge, and Dr. H. Ross: Discussion on Health Problems in Industry.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Summer Meeting), 2.30 to 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Alexander C. Mackenzie: Beethoven.

INSTITUTE OF PATHOLOGY AND RESEARCH (at St. Mary's Hospital), at 4.30.—Prof. G. Dreyer: A New Departure in the Serum Diagnosis of Syphilis.

ROYAL SOCIETY, at 4.30.—Dr. T. M. Lowry and Dr. C. P. Austin: Optical Rotatory Dispersion (The Bakerian Lecture).

LINNEAN SOCIETY, at 5.—Prof. Garstang and Others: Discussion on Biogenetic Law (Recapitulation).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. M. Fletcher: Building a House.
CHEMICAL SOCIETY, at 8.—H. King: Derivatives of Sulphur in Commercial Salvarsan. Part I.—S. Glasstone: Physical Chemistry of the Oxides of Lead. Part I. The Solubility of Lead Monoxide.—M. O. Forster and W. B. Saville: Studies in the Camphane Series. Part XXXIX. *p*-Aminophenylaminocamphor (Camphoryl-*p*-phenylenediamine).—K. Stratton and J. R. Partington: Latent Heats of Fusion. Part I. Benzophenone, Phenol, and Sulphur.—G. T. Morgan and H. D. K. Drew: Researches on Residual Affinity and Co-ordination. Part V. Gallium Acetylacetone and its Analogues.—J. C. Thomlinson: Analysis of Cresol Disinfectants.—G. T. Morgan and D. Webster: Diazo-derivatives of 4-amino-phenyl-4′-methylbenz-2′:7′-thiazole (Dehydrothio-*p*-toluidine).—A. K. Macbeth and D. D. Pratt: The Labile Nature of the Halogen Atoms in Substituted Nitromethanes.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C:S:S$) and Dithioethers ($R_2S:S$). Part II.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C:S:S$) and Dithioethers ($R_2S:S$). Part III. Interaction of Sulphur Monochloride with Organic Compounds containing the grouping

$$—CO—CH_2—CO—CH_2—CO—.$$

K. G. Naik: The Formation and Properties of Dithioketones ($R_2C:S:S$) and Dithioethers ($R_2S:S$). Part IV. Interaction of Sulphur Monochloride with Organic Compounds containing —CO—CH_2—CO— grouping, forming the Part of a Closed Ring.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C:S:S$) and Dithioethers ($R_2S:S$). Part V. Nitration of Dithioketones and Dithioethers.—K. G. Naik: Interaction of Sulphur Monochloride with Organic Acid Amides.—S. J. Lewis and F. M. Wood: A New Adjustable Thermostat for all Temperatures between 0° and 100°.—H. Burton and J. Kenner: The Influence of Nitro-groups on the Reactivity of Substituents in the Benzene Nucleus. Part III. The Partial Reduction of the Dinitrotoluenes by Stannous Chloride and Hydrochloric Acid.—J. Kenner and E. Witham: The Influence of Nitro-groups on the Reactivity of Substituents in the Benzene Nucleus. Part IV. The Condensation of Ethyl 3- and 5-nitro-*o*-Chlorobenzoates with Hydrazines.
SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 8.15.—Prof. Abercrombie: The Municipal Survey of Sheffield.

FRIDAY, JUNE 3.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Summer Meeting), 10 to 1.
ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science), at 2.30.—F. L. Engledow: Methods of Increasing Yield in Crop Plants.—C. B. Saunders: Some Problems of Seed Testing.—W. Brown: The Physiology of Infection.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1) (Adjourned Meeting), at 5.—Lt.-Col. H. Kirkpatrick: Some Points on Trachoma.—C. França: An Early Portuguese Contribution to Tropical Medicine.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—M. Adams: Eyes in Portraiture.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. L. Huxley: Chronicles of the *Cornhill*.

SATURDAY, JUNE 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. S. Rait: Scotland and France.

MONDAY, JUNE 6.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Prebendary H. E. Fox: The Roman Wall in North Britain.
INSTITUTE OF ACTUARIES (Annual General Meeting), at 5.
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. L. Levy: Industrial Respirators.—Prof. K. G. Naik: The Gold and Silver Thread Industry in India.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—E. Teichman: Journeys in Kam.

TUESDAY, JUNE 7.

ROYAL HORTICULTURAL SOCIETY, at 3.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir James Frazer: London Life: Time of Addison.
MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Maudsley Hospital, Denmark Hill), at 4.30.—Sir Frederick Mott: Second Maudsley Lecture.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. F. M. Chapman: The Distribution of Bird-life in the Urubamba Valley of Peru.—S. Maulik: New Indian Drilid Beetles.—Prof. J. P. Hill: Exhibition of Some Marsupial Embryos, especially the Koala and the Wombat.—R. I. Pocock: The External Characters of the Koala (Phascolarctos) and Some Related Marsupials.—Dr. C. F. Sonntag: The Comparative Anatomy of the Koala (*Phascolarctos cinereus*) and the Vulpine Phalanger (*Trichosurus vulpecula*).

WEDNESDAY, JUNE 8.

BRITISH SCIENCE GUILD (Annual Meeting) (at Goldsmiths' Hall, Foster Lane), at 3.—Lord Montagu of Beaulieu: The Work of the Guild.—The Dean of St. Paul's: The Road to Ruin and the Way Out.—Sir Richard A. S. Redmayne: The Importance of Research in Promoting the Development of the Mineral Industries.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. Fraser Hume: The Relations of the Northern Red Sea and its Associated Gulf Areas to the "Rift" Theory.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Savoy Place), at 6.—Prof. J. S. Townsend: Electric Oscillations along Straight Wires and Solenoids.

THURSDAY, JUNE 9.

INSTITUTION OF MINING ENGINEERS (at Geological Society), at 11.—Third Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines."—J. P. Rees: Observations of Temperature and Moisture in Deep Coal-mines.—Prof. H. Briggs: Characteristics of Outbursts of Gas in Mines.—H. C. Harrison: The Use and Distribution of Shale-dust in Mines. The following papers, which have already appeared in the Transactions, will be discussed:—A. E. Beet and A. E. Findley: The Better Utilisation of Coking Slack.—J. I. Graham: The Normal Occurrence of Carbon Monoxide in Coal-mines.—T. L. Galloway: An Improved Method of Determining the Relative Directions of Two Reference-lines or Bases for Mining Surveys.—E. Bury, W. Broadbridge, and A. Hutchinson: Froth Flotation as Applied to the Washing of Industrial Coal.
INSTITUTE OF PATHOLOGY AND RESEARCH (at St. Mary's Hospital), at 4.30.—Dr. H. Head: Release of Function in the Nervous System.
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. C. S. Sherrington: Break-shock Reflexes and "Supramaximal" Contraction-response of Mammalian Nerve-muscle to Single-shock Stimuli.—R. J. Ludford and J. B. Gatenby: Dictyokinesis in Germ Cells, or the Distribution of the Golgi Apparatus during Cell Division.—Dr. F. W. Edridge-Green: The Effect of Red Fatigue on the White Equation.—E. Ponder: A Method for Investigating the Hæmolytic Activity of Chemical Substances.—W. H. Pearsall: The Development of Vegetation in the English Lakes, considered in Relation to the General Evolution of Glacial Lakes and Rock Basins.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—M. J. Conran: Curvature and Torsion in Elliptic Space.—J. L. S. Hatton: The Inscribed, Circumscribed, and Self-conjugate Polygons of Two Conics.—M. J. M. Hill: The Differential Equations of the First Order derivable from an Irreducible Algebraic Primitive.—F. S. Macaulay: Note on the Resultant of a Number of Polynomials of the Same Degree.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. L. Golla: The Objective Study of Neurosis (Croonian Lecture).
OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—H. Lee: Achromatism.—W. L. Custance: Demonstration of the Société Genevoise Universal Measuring Machine.

FRIDAY, JUNE 10.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir George Seymour Curtis: The Development of Bombay.
ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Sir Ernest Rutherford: The Stability of Atoms (Lecture).
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. G. Webster: Absolute Measurements of Sound.

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