NATURE

SATURDAY, APRIL 22, 1922.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

British Dyestuffs Industry.

THOSE who scrutinise with anxious attention the progress of the British dyestuffs industry are aware that the stage now reached is one surrounded by dangers of a character more economic than technical. The Dyestuffs (Importation) Act has been in operation during fifteen months, and at the outset of this period two main factors contributed to smooth administration. As a consequence of the Sankey judgment, this country had been flooded with German dyes in quantity and variety amply sufficient to supply the normal needs of one year's good trade; concurrently, every branch of industry was facing an abnormal depression, which reflected itself in a greatly diminished consumption of dyestuffs. It followed that the principal problems arising in regard to licensing imports were questions affecting identity or equivalence of the domestic dyes when competing with foreign products.

The period under review has been one of steady progress by the British factories, and an opportunity to visualise their achievement was offered lately by an imposing exhibition of synthetic colouring matters at the British Industries Fair. Still more recently, Brig.-Gen. Sir William Alexander, Chairman of the British Dyestuffs Corporation, invited a large gathering of press representatives to review the circumstances in which the renascence of this industry took place, and to apprehend the nationally fundamental need of maintaining it. There is grave public danger in the present risk that, as the connection between dyestuffs and explosives recedes into the background of the public mind, the more permanently important features of this industry will sink into oblivion. Failure to realise how closely the chemical industry is linked with the general manufacturing activities of the country springs from the apathy with which chemistry, particularly the organic branch, has been regarded in Great Britain, and Sir William Alexander has rendered a public service in emphasising the fact that research in the dyestuff industry creates and maintains a very highly trained body of organic chemists who, in an emergency, are qualified to apply themselves to technical national problems, whether these relate to peace or war.

This admonition is a timely one, because a variety of circumstances indicate growth of opposition to the principle of the Dyestuffs (Importation) Act. At the moment, although great strides have been made by the research departments of the British factories towards improving the quality and diminishing the cost of their colours, prices are still in many cases higher than can be viewed with equanimity by the dyer or calico-printer, and advantage is being taken of this drawback by those who, from motives of gain, or in disregard of national interests, seek the repeal of the Act. Owing to countless variations of detail in the application of dyestuffs to textiles, it is difficult to secure trustworthy information respecting the percentage of cost borne by a colouring matter in the finished product; in some cases it is trifling, in others it may be substantial, and in the general scramble to reduce cost of production, it is natural for those colour-users whose range of vision is not wide to pounce upon the dye-costs and demand relief. Meanwhile, the opportunity now in the hands of German factories owing to currency depreciation is one which they have not been slow to use, but it would be foolish to imagine that any mercy will be shown by Germany to British colour-users if once the domestic industry is allowed to perish.

Happily there are colour-users who look beyond the needs of the moment, and to such it is evident that the effort now being made to shatter the industry in adolescence must, in the interest of the whole community, be faced and overcome. If this country is not allowed to establish a dye-making industry, incalculable damage will ultimately accrue to the textile trade. In the first place, the dyer will suffer in becoming a spoon-fed vassal of the German factories; he will grow less and less capable of exercising his craft intelligently, and of devising novel applications to textile fabrics. This will diminish the attraction which British products offer to foreign markets, and in that degree curtail the operations of the textile manufacturer, who will be further handicapped by exorbitant prices for German dyes. Finally, if this, the principal industrial incentive to the pursuit of applied organic chemistry be permitted to languish, this country deliberately excludes itself from the immediate benefits, and the potential profits, of all future revolutionary discoveries comparable with that which, in 1856, led to the displacement of natural colouring matters by the products of coal-tar chemistry.

Sexual Life and Marriage among Primitive Mankind.

The History of Human Marriage. By Prof. E. Westermarck. Fifth edition, rewritten. Vol. 1, pp. xxiv + 571. Vol. 2, pp. xii + 595. Vol. 3, pp. viii + 587. (London: Macmillan and Co., Ltd., 1921.) Three Volumes. 84*s.* net.

COMPARATIVE sociology, in many of its branches, started with very simple and homely concepts, and now, after a career of imaginative and somewhat sensational spinning of hypotheses, we find it returning in its latest developments to the position of common sense. The subject of family and marriage, of their origins and evolution, epitomises such a typical course of sociological speculation. In the views about the human family, there was first the uncritical assumption that the family was the nucleus of human society; that monogamous marriage has been the prototype of all varieties of sex union; that law, authority and government are all derived from patriarchal power; that the State, the Tribe, economic co-operation and all other forms of social association have gradually grown out of the small group of blood relatives, issued from one married couple, and governed by the father. This theory satisfied common sense, supplied an easily imaginable course of natural development, and was in agreement with all the unquestioned authorities, from the Bible to Aristotle.

But some sixty years ago, among the many revolutions in scientific thinking and method, the family theory of society seemed to have received its death-blow. The independent researches of Bachofen, Morgan and MacLennan seemed to prove beyond doubt, by the study of survivals and ethnographic phenomena, by methods of linguistics, comparative study and antiquarian reconstruction, that the whole conception of primeval monogamous marriage and early human family was nothing but a myth. Primitive humanity, they said, lived in loosely organised hordes, in which an almost complete lack of sexual regulation, a state of promiscuity, was the usage and law. This, the authors of this school concluded, can be seen from many survivals, from the analysis of classificatory systems of relationship, and from the prevalence of matrilineal kinship and matriarchate. Thus, instead of the primitive family we have a horde; instead of marriage, promiscuity; instead of paternal right, the sole influence of the mother and of her relatives over the children. Some of the leaders of this school constructed a number of successive stages of sexual evolution through which humanity was supposed to have passed. Starting from promiscuity, mankind went through group marriage, then the so-called consanguineous family or Punalua, then polygamy, till, in the highest civilisations, monogamous marriage was reached as the final product of development. Under this scheme of speculations, the history of human marriage reads like a sensational and somewhat scandalous novel, starting from a confused but interesting initial tangle, redeeming its unseemly course by a moral *dénouement*, and leading, as all proper novels should, to marriage, in which "they lived happily ever after."

After the first triumphs of this theory were over, there came, however, a reaction. The earliest and most important criticism of these theories arose out of the very effort to maintain them.

In the middle eighties of last century, a young and then inexperienced Finnish student of anthropology started to add his contribution to the views of Bachofen and Morgan. In the course of his work, however, the arguments for the new and then fashionable theories began to crumple in his hands, and indeed to turn into the very opposite of their initial shape. These studies, in short, led to the first publication by Prof. Westermarck in 1891 of his "History of Human Marriage," in which the author maintained that monogamous marriage is a primeval human institution, and that it is rooted in the individual family; that matriarchate has not been a universal stage of human development; that group marriage never existed, still less promiscuity, and that the whole problem must be approached from the biological and psychological point of view, and though with an exhaustive, yet with a critical application of ethnological evidence. The book with its theories arrested at once the attention both of all the specialists and of a wider public, and it has survived these thirty years, to be reborn in 1922 in an amplified fifth edition of threefold the original size and manifold its original value. For since then Prof. Westermarck has developed not only his methods of inductive inference by writing another book of wider scope and at least equal importance, "Origin and Development of Moral Ideas," but he has also acquired a first-hand knowledge of savage races by years of intensive ethnographic field work in Morocco, work which has produced already numerous and most valuable records.

Where does the problem stand now? First of all, the contest is not ended yet, and divergencies of opinion obtain on some fundamental points, while controversy has not lost much of its uncompromising tone. But the issues have narrowed down somewhat. There is no longer a question of accepting the naïve theory which regarded family as a kind of universal germ of all social evolution; nor, on the other hand, does any competent sociologist take very seriously the fifteen successive stages of promiscuity, group marriage, Punalua marriage, etc. Prof. Westermarck and his school do not maintain the rigidly patriarchal theory, and they are fully aware of the importance of matrilineal descent, of the maternal uncle's authority, and of the various kinship anomalies connected with matriliny. The classificatory terms of relationship are, moreover, not considered by Prof. Westermarck as mere terms of address, but as important indications of status.

The representatives of the opposite school had also to make some concessions, though rather reluctantly and grudgingly. Scarcely any one nowadays would be so irreverent towards our ape-like ancestors and ancestresses as to suspect them of living in a general state of promiscuity. But there is still a formidable list of names, among them some of the most eminent representatives of modern anthropology, quoted by Prof. Westermarck (vol. 1, p. 103 *n.*), who consider primitive promiscuity as "not improbable," "plausible," "by no means untenable," and use this hypothesis constantly as a skeleton-key to open all questions of sex. Group marriage is still, though somewhat faintheartedly, affirmed to have existed, and even some savages are forced to live up to their evil reputation—in the speculations and bare assertions of some writers. The Punalua family leads an even more shadowy existence, merging into a combined polyandry and polygamy. The most tenacious survival of the Bachofen-Morgan-MacLennan theories seems to be the kinship terms, themselves a most fecund breeding-place for all kinds of survival theories.

Thus Prof. Westermarck in this new edition is not altogether relieved of the necessity of dealing with the hypothesis of promiscuity, and in chapters iii.-ix. he examines the various classes of evidence adduced in its favour. There is a number of statements affirming directly the existence of promiscuous conditions among this or that tribe or people. Some of them come from garrulous and credulous writers of antiquity and have to be discarded as pure fables; others, from modern travellers, equal them in untrustworthiness and futility. On this point no one will certainly controvert the author when he says "that it would be difficult to find a more untrustworthy collection of statements." The investigation then turns to that remarkable group of ethnological facts—*Jus Primae Noctis*, licence of festive and religious character, prenuptial and orgiastic sexual intercourse—in which the powerful instinct of sex, curbed and fettered by social regulations, takes, in its own time, revenge on man by dragging him down to the level of a beast. Prof. Westermarck fully admits the importance and extent of these phenomena; his survey indeed shows the extreme range and the often astounding perversity of these deviations. But he declines resolutely to see in any of these facts a survival of pristine promiscuity, for in all cases the facts reveal most powerful motive forces, and can be attributed to definite psychological and social causes. The theory of survival is moreover irreconcilable with the fact that we find side by side with licentious tribes, savages who maintain strict chastity; that some of the most primitive ones are virtuous, whilst the most luxuriant growth of licence is found in more advanced communities; that, finally, civilisation instead of abolishing these phenomena only modifies them.

The chapters on customary and regulated sexual licence are full of penetrating suggestions, and the facts, skilfully marshalled, are made to speak for themselves, and will supply a lasting compendium for students of sexual psychology. But what appears most valuable in this, not less than in other parts of the work, are the methods and implications of the argument. Prof. Westermarck has an abhorrence of the now fashionable tendency of explaining the whole by its part, the essential by the irrelevant, the known by the unknown. He refuses to construct out of meagre and insufficient evidence a vast, hypothetical building, through the narrow windows of which we would have to gaze upon reality, and see only as much of it as they allow. The obvious, common-sense and essentially scientific way of proceeding is to get firm hold of the fundamental aspects of human nature—in this case the psychology of sex, the laws of primitive human grouping, the typical beliefs and sentiments of savage people—and, in the light of this, to analyse each fact as we meet it. But to construct the unverifiable hypotheses of primitive promiscuity and interpret facts in terms of figments is, as Prof. Westermarck shows, a method which leads nowhere and lures us from the true scientific path.

Some of the other chapters of Prof. Westermarck's book give us another approach to the psychology of sex and to the theory of human marriage. Sex is a most powerful instinct—one of the modern schools of psychology tries to derive from it almost all mental process and sociological crystallisation. However this may be, there is no doubt that masculine jealousy (chap. ix.), sexual modesty (chap. xii.), female coyness (chap. xiv.), the mechanism of sexual attraction (chap. xv. and xvi.) and of courtship (chap. xiii.)—all these forces and conditions made it necessary that even in the most primitive human aggregates there should exist powerful means of regulating, suppressing and directing this instinct. There is no doubt that all the psychological forces of human sexual passion, as well as the conditions of primitive life, must have tended to produce a primeval habit of individual pairing. We have to imagine a man and a woman forming more or less permanent unions which lasted until well after the birth of the offspring. This, Prof. Westermarck develops in the first chapter of his work. A union between man and wife, based on personal affection springing out of sexual attachment, based on economic conditions, on mutual services, but above all on a common relation to the children, such a union is the origin of the human family. This primeval habit, according to the "tendency of habits to become rules of conduct," develops with time into the institution of family and marriage, and "marriage is rooted in the family, rather than the family in marriage."

Marriage, indeed, right through the book, is conceived in the correct sociological manner, that is, as an institution based on complex social conditions. The greatest mistake of the writers of the opposing school—a mistake which, I think, they have not corrected even in the most recent publications—is their identification of marriage with sexual appropriation. Nor is this pitfall easy to avoid. For us, in our own society, the exclusiveness of sexual rights is the very essence of marriage. Hence we think of marriage in terms of individual sexual appropriation, and project this concept into native societies. When we find, therefore, groups of people living in sexual communism, as undoubtedly happens among a few tribes within a limited compass, we have a tendency at once to jump to conclusions about "group marriage."

To the majority of savages, however, sexual appropriation is by no means the main aspect of marriage. To take one example, there are the Trobriand Islanders, studied by the present writer, who live in the greatest sexual laxity, are matrilineal, and possess an institution which is probably the nearest approach to "group marriage" that exists or could ever have existed. Indeed, it resembles it much more, I think, than does the celebrated Pirrauru of the Dieri in Central Australia. These natives satisfy their sexual inclinations through all forms of licence, regulated and irregular, and then settle down to marry, decidedly not only or even mainly to possess a partner in sex, but chiefly out of personal attachment, in order to set up a household with its economic advantages, and last, not least, to rear children. The institution of individual marriage and family among them is based on several other foundations besides sex, though sex—naturally—enters into it.

Space does not allow me to follow Prof. Westermarck into his dialectic contests with the most eminent of his contemporaries—with Sir James Frazer and Dr. Rivers about the kinship terms (chap. vi.); with Sir James Frazer and Mr. Hartland on matriliny (chap. viii.); and with all of them, as well as Spencer and Gillen, on group marriage (chap. xxvi.). In all these arguments we find the same extensive use of ethnological material, the same breadth of view and moderation of doctrine, above all, the same sound method of explaining the detail by its *whole*, the superstructure by its foundation. In the treatment of kinship and matriliny, too little concession is perhaps made to the important theories of Sir James Frazer and Mr. Hartland, whose views, unquestionably correct, that ignorance of paternity is universal and primitive among savages, Prof. Westermarck cannot accept. Nor can he see perhaps sufficiently clearly the enormous influence of this savage ignorance on primitive ideas of kinship. As Sir James Frazer says:

"Fatherhood to a Central Australian savage is a very different thing from fatherhood to a civilized European. To the European father it means that he has begotten a child on a woman; to the Central Australian father it means that the child is the offspring of a woman with whom he has a right to cohabit. . . . To the European mind the tie between a father and his child is physical; to the Central Australian it is social" ("Totemism and Exogamy," i. p. 236). The distinction between a physiological and a social conception of kinship is indeed essential. But, on the whole, Prof. Westermarck's views do not diverge so much from those of Frazer's, who, on the other hand, occupies a moderate position among the supporters of the opposite theories.

Prof. Westermarck's explanation of exogamy, and of the prohibition of incest—which I think will come to be considered as a model of sociological construction, and which remarkably enough seems to find favour with no one—can only be mentioned here. The excellent chapters on marriage rites (chaps. xxiv.-xxvi.); the analysis of what could be called the numeric varieties of marriage, monogamy and polygamy (chaps. xxvii.-xxviii.); polyandry (xxix.-xxx.); duration of marriage (xxxii.-xxxiii.), stand somewhat apart from the main argument of the book. Each division is a monograph, a *Corpus Inscriptionum Matrimonialium*, a treatise in itself.

The book is and will remain an inexhaustible fount of information, a lasting contribution towards the clearing up of some of the most obscure aspects of human evolution, and it marks an epoch in the development of sociological method and reasoning.

B. MALINOWSKI.

Some Chemical Treatises.

(1) *Fundamental Principles of Organic Chemistry.* By Prof. C. Moureu. Authorised Translation from the Sixth French Edition by W. T. K. Braunholtz. Pp. xviii+399. (London: G. Bell and Sons, Ltd., 1921.) 12*s.* 6*d.* net.

(2) *A Text-book of Inorganic Chemistry.* Edited by Dr. J. N. Friend. Vol. 9, part 2, *Iron and its Compounds.* By Dr. J. N. Friend. (Griffin's Scientific Text-books.) Pp. xxv+265. (London: Charles Griffin and Co., Ltd., 1921.) 18*s.*

(3) *A Dictionary of Chemical Solubilities. Inorganic.* First edition by Dr. A. M. Comey. Second edition, enlarged and revised, by Dr. A. M. Comey and Prof. Dorothy A. Hahn. Pp. xviii+1141. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 72*s.* net.

(1) THE wealth of material comprehended by organic chemistry constitutes a very real and formidable difficulty to the instructor in that branch of science. It is calculated that up to the present time more than two hundred thousand organic substances have been discovered and described, and the number is being steadily added to week after week. It is obviously impossible for any lecturer on the subject to deal with more than a very small fraction of this *materia chemica.* Nor is there any reason why he should. Fifty or sixty years ago organic chemistry was scarcely taught in our universities, and, even when taught, was treated in a lifeless, unsystematic manner. Students, far from being attracted towards it, were frankly bored by the uninteresting recapitulation of empirical facts, methods of preparation, and physical properties, which usually made up the substance of the teacher's prelections. All this, however, is now changed. The enormous accretion of fact has been brought under law and order. The whole has been collated, and, for the most part, reduced to fundamental principles. The view of the village is no longer obscured by the houses.

It is with these fundamental principles alone, based upon the co-ordination of facts, or groups of facts, that the teacher of organic chemistry to-day can concern himself, if he would seek to convey any adequate conception of the field of study occupied by that department of science. In the hands of a capable, well-informed man, gifted with philosophic insight and endowed with the faculty of exposition, tuition in organic chemistry can be made a most fascinating occupation. To supplement the teacher's work in the lecture-room, however, the students should be provided with a well-ordered text-book, dealing with the principles concerned. Such a book is that under review. In its original form it has already been noticed in these columns. Since that time it has gone through many editions, and has found its way beyond French university circles. The sixth French edition has now been translated into English by Mr. Walter T. K. Braunholtz, and appears with an introduction from Prof. Sir William J. Pope, of the University of Cambridge.

We heartily commend Prof. Moureu's book to all—both teachers and taught—to whom the philosophic aspects of organic chemistry appeal. No more interesting work on the subject has appeared within recent years. It is written with that clarity, logical sense, faculty of arrangement, and sense of proportion which are such striking characteristics of French scientific literature. We trust that in its English dress it will have a reception commensurate with its great merits.

(2) As was mentioned in a former notice in NATURE of vol. 9 of Dr. Newton Friend's great work on inorganic chemistry, it has been found necessary to treat the subject of iron in a separate part of that volume, on account of the great importance of the metal and the voluminous literature which has grown round it. This has been found so great that it has been deemed desirable to subdivide the volume still further. The part now under review treats of the chemistry of iron and its compounds, its metallurgy being relegated to part 3, which is being dealt with by the editor in collaboration with Mr. W. H. Hatfield.

The general plan of part 2 is similar to that of the preceding volumes. It opens with an account of the early history of iron as a metal, beginning with the use of meteoric iron by prehistoric man, and of smelted iron by the Egyptians, Ethiopians, Assyrians, and Israelites. According to authorities quoted by Dr. Friend, India acquired her knowledge of iron from Babylon. The famous pillar at Delhi is far from being so old as is usually surmised. It dates back probably to about A.D. 300. Greece was the first country in Europe to use iron—probably about 1400 B.C. It was known in Britain about a century before the Roman invasion, when, as mentioned by Cæsar, it was used in the form of bars for currency. Specimens of these bars are in the British Museum and in the Worcester Museum. Chap. 2 is concerned with the mineralogy of iron, and gives an account of its ores and other ferruginous minerals, many of which, of course, are of no importance as sources of the metal. It is noteworthy that the mean percentages of ferrous and ferric oxides contained in American igneous rocks are considerably less than in similar British rocks. Chap. 3 treats of the preparation and properties of pure iron, the passivity of iron, its action as a catalyst, etc. A short section on its atomic weight is contributed by Mr.

Little. The final value 55·84 is sufficiently far from a whole number to suggest the existence of isotopes, for there is every reason to believe that this value is well established. In view of Dr. Aston's work, and the resuscitation of Prout's hypothesis, it will be interesting to learn how the difference from the integer is to be accounted for. Chap. 4 deals with the important subject of the corrosion of iron, of which the editor has made a special study. It is, however, remarkable, in spite of the large amount of work which has already been done on this subject, how much remains to be ascertained. The remaining chapters, five in number, deal with the general properties of iron salts, of its compounds with hydrogen and the halogens, and with the elements of Groups VI., V., IV., and III. of the Periodic Table. The whole concludes with a chapter on the detection and estimation of iron.

As in the case of the entire work, a special feature is a wealth of bibliographical reference. Practically every statement can be verified by reference to the original source of information. This, of course, adds greatly to the value of the treatise as a compendium, but it is naturally not of much service to the student without access to a well-found library. There is probably no single library in London in which all the books thus referred to could be found.

A new feature in the work is the inclusion of a table giving a list of important journals and periodicals dealing with chemical matters, with the dates of issue of their several volumes, from the year 1800 down to 1919. It was compiled by Mr. Clifford, the librarian of the Chemical Society, and occupies some eight pages of the book. Its value to the book itself is not very apparent, since the date of publication in the case of any particular reference is invariably given in the footnote. The table has no special appropriateness to the volume under review; its proper place would be either at the beginning or the end of the completed work.

(3) The "Dictionary of Chemical Solubilities," by Drs. A. M. Comey and Dorothy A. Hahn, is a revised and enlarged edition of a work by the first-named author which appeared in 1895, and which, in its turn, followed the well-known "Dictionary of Solubilities" compiled in 1864 by Prof. F. H. Storer on a plan indicated so far back as 1731 by Peter Shaw. Storer's book is long since out of print, and no attempt has been made to bring it up to date and to reissue it. During the quarter of a century which has elapsed since the first edition of Dr. Comey's work a large amount of additional matter relating to the solubilities of inorganic substances, with which the book is alone concerned, has made its appearance. This has been carefully brought together by Dr. Dorothy A. Hahn, of Mount Holyoke College, and forms the material upon which the present edition is based. It constitutes a volume of 1140 closely printed pages, and its subject-matter has been brought down to 1916. Its printing and publication have been delayed by circumstances arising out of the war.

In a work of this kind easy reference is of primary importance, and opinions may differ as to the best arrangement to adopt. The one used is practically alphabetical, but it will be obvious that such a scheme leads to occasional anomalies, which could be obviated only by elaborate cross-referencing, thereby adding considerably to the bulk of the volume. In the case of discrepant statements by different observers, no attempt at a critical selection has been made, which we think detracts from the value and authority of the work. A careful examination of the original papers and of the methods and apparatus employed would have enabled a satisfactory judgment to be reached, and thereby obviated much unnecessary printing. Methods of determining the solubilities of gases, for example, have been improved greatly since Bunsen's time, and many of his estimations have been superseded by more accurate observations. It serves no useful purpose to retain them, and indeed only confuses the searcher, who is not in a position to discriminate between the several observers. The compilers may rightly say they have done their best to deal with the enormous mass of material they have collected, but they can scarcely have escaped the conviction that much of the numerical data rests upon a very insecure experimental basis. The fact is, it is only within quite recent times that methods of estimating solubilities have reached the necessary precision, and that sources of error hitherto overlooked have been obviated.

In spite, however, of these difficulties and imperfections, the present work is the most comprehensive compilation on the subject which has yet appeared in any language, and a word of commendation is due to Dr. Hahn for the patience, care, and assiduity with which she has collected the vast amount of material with which she has had to deal.

Formal and Philosophical Aspects of Logic.

Logic. By W. E. Johnson. Part 1. Pp. xl+255. 16*s*. net. Part 2. Demonstrative Inference: Deductive and Inductive. Pp. xx+258. 14*s*. net. (Cambridge: At the University Press, 1921, 1922.)

A LOGICIAN is a person who takes infinite pains to solve problems which present no manner of difficulty to ordinary mortals. This may be, and no doubt is, because ordinary mortals live and die unconscious of the inconsistencies of general theory. The logician is therefore of necessity a very serious person, and to suspect a twinkle in his eye when he is propounding his problem is to undermine his authority. But there is another reason why he must be serious. If he would make formal logic a distinctive science he must walk warily between the devil and the deep sea, for on the one hand he has to beware of falling into pure matters of grammar, the use and misuse of the parts of speech, and on the other hand he has to avoid the abyss of metaphysics. Indeed if one were to take a pencil and score through everything in a treatise on logic which really depends on an intelligent understanding and use of grammar and everything also which depends on a disputable metaphysical theory, it would be difficult to be sure that anything would remain. There used to be a subject, taught at universities, called rhetoric, and many chairs of it still survive, but it would puzzle any one now to say definitely what a professor of rhetoric is expected to teach. It looks as though logic may some day and very soon be in a similar case.

Two parts of Mr. Johnson's logic are yet to come. The two parts before us are exceedingly well written. Every sentence is a model of clearness and lucidity. However puzzled the reader may be when he discovers the sort of problems he is invited to discuss, if he yields to the spell and plays the game, he will find a certain philosophical interest which will engage his attention throughout.

The influence of "Principia Mathematica" is very much in evidence; probably without that work few of the problems here dealt with would have had any *raison d'être*, even if they had been discovered to exist. Thus Mr. Johnson makes a very important point of a division he proposes between propositions, verbally identical, into primary and secondary. Truth and falsity, he tells us, can be predicated of propositions in quite different senses according as they are one or the other. "Some fairies are malevolent" if it is a primary proposition is necessarily false because fairies do not exist. But if it applies to "descriptions" of fairies then, as descriptions exist, it is true, and it is a secondary proposition. Similarly, in the chapter on negation we are asked to consider propositions such as these opposites. "An integer between 3 and 4 is prime" and "An integer between 3 and 4 is composite." Here we are told that though one is contradictory of the other, neither is true because both have a non-existent subject. This is in keeping with the endless interest Mr. Russell discovered in the question of the truth or falsity of the proposition "The present King of France is bald." All one can say is that if any nonsensical content becomes a proposition once it is invested with the propositional form, then logic had better be abandoned to those for whom games are the serious business of life.

The author's main purpose, however, seems to be a more exact classification and an improved terminology. He thinks the serious objection urged against the correspondence theory of truth can be got rid of by substituting the terms "accordance" and "discordance" for correspondence and non-correspondence. We may admit that the new terms are in a sense non-committal, but is that a gain? Another proposal is concerned with the subject of Modality. It is to substitute "certified and uncertified," for the term problematic, and to distinguish the certified into formally certified and experientially certified, apparently in order to have technical terms in logic for the old philosophical distinction between truths of reason and matters of fact. Also for "necessary" he would substitute two pairs of terms, nomic and contingent, and, epistemic and constitutive. The peculiar character of proper names he proposes to designate by the term "ostensive." In all this we seem to be hearing the echo of Mr. Russell's complaint that we shall never make progress in science until we construct and use a scientific language.

Perhaps the most novel thing in the logical theory expounded in Part 1 is the Paradoxes of Implication. The "typical paradox" is certainly not what we ordinarily designate by that term, and the author is aware that his use requires justification. A paradox in the ordinary meaning is the affirmation of a proposition the actual terms of which include its negation, as for example, "Whoso loses his life shall save it." The essence of the paradox is that despite its apparent contradiction in form it contains defensible philosophic truth. The logical paradox here discussed is very different. You may be led by implication (p implies q) technically correct, to the form "if p then q" where p may stand for the proposition $2+3=7$ and q for the proposition "it will rain to-morrow," then you have the paradox. At this point no doubt the ordinary person would lose interest, but if you are a logician it is here the problem becomes engrossing.

One very interesting discussion, also in Part 1, is the famous Leibnizian principle of "the identity of indiscernibles." No one can fail to see that metaphysically the principle is an essential part of the concept of substance, yet logically there seems no way of keeping this in view, and the author reaches the conclusion—which is quite correct on his principles—that it seems to him in any case to have no logical justification whatever.

In Part 2 there is a distinct increase in the philosophical interest. The difference between the aspect of a problem to the philosopher and to the logician becomes more marked, and the author is sometimes at pains to show that the doctrine he is discussing has reference purely to formal logic. The subjects dealt with are of the first importance. For example, the relation of logic to mathematics is discussed with very penetrating criticism, and Mr. Johnson finds that he differs from Mr. Russell on the fundamental concept of this relation. The mathematical function is for Mr. Russell a description derivable from the propositional function of logic, whereas Mr. Johnson argues that the propositional function of logic is nothing but a particular case of the mathematical. In discussing functional deduction generally Mr. Johnson says "the essential purpose of symbolism is to economise the exercise of thought; and thus symbolic methods are worse than useless in studying the philosophy of symbolism or of mathematics in particular."

There are many new distinctions discovered and new terms proposed. In particular we are to distinguish two direct principles of inference, the applicative and the implicative, each with a counter principle; we are to add to the distinctions of magnitudes as extensive and intensive an intermediate form termed distensive; and, more important still, we are to distinguish between the question of the absoluteness or relativity of space and time and the question of their substantival or adjectival nature. But perhaps the most astonishing distinction of all (is it a new discovery?) is that of the syllogism and the antilogism. The antilogism like the syllogism has its four modes AEIO, and, in the illustration given, simply by altering the mode we can present the argument for new realism, the argument for Hume's scepticism, or the argument for Kant's formalism. Verily formal logic may be in the way of becoming a formidable weapon in the hands of a philosophical controversialist.

Terrestrial Magnetism in the Antarctic.

British ("Terra Nova") Antarctic Expedition, 1910–1913: Terrestrial Magnetism. By Dr. C. Chree. Pp. xii+548+60 plates. (London: Harrison and Sons, Ltd., 1921.)

BOTH of Captain Scott's Antarctic expeditions included observations of the earth's magnetism in their programme of scientific work, and the experience gained in the first was turned to good use in the second. The two magnetic observers were Dr. G. C. Simpson and Mr. C. S. Wright, to whom is due the credit for the fine work done at the base station. A noteworthy improvement was made by Dr. Simpson in the method of time-marking on the magnetograph sheets, which has since been adopted in some regular magnetic observatories. The magnetographs were in operation for nearly two years (February 1911 to November 1912); at the beginning of the second year Dr. Simpson was recalled to his official duties in India. Besides the continuous record of the three magnetic elements at Cape Evans, a considerable number of absolute measurements were made by the naval officers of the expedition, both in the "field" (principally at Cape Adare) and at sea.

The important task of preparing a report describing and discussing all these observations was entrusted, as in the case of the former expedition, to Dr. Chree. This report has just been issued, in the form of a large quarto volume, prepared and published at the cost of the fund raised by public subscription in memory of Captain Scott and his companions. Apart from the observations taken by the naval officers, which were mainly reduced by themselves, not only the discussion but also the reduction of the observations has been executed by or under the supervision of Dr. Chree; the measurement of the magnetograph curves, the reduction of the measurements, and the discussion of the important but somewhat tedious instrumental questions which arise, involve an amount of labour which can be but little appreciated by those unfamiliar with the subject. Of the 548 pages of letterpress, about one hundred are devoted to the tables, giving hourly values of the three magnetic elements, while about one-quarter of the volume is occupied by a valuable set of plates, mainly reproducing actual magnetograph records, from the Antarctic or elsewhere.

Following out his characteristic plan, Dr. Chree has kept strictly to the comparison and discussion of facts as facts; the echoes of theoretical controversy can be at most remotely perceived, and speculations as to the cause of the phenomena reviewed with such painstaking care are expressly deprecated by the author. Whether or not it is best at all times to restrict the discussion within these severe limits of certainty, few can disagree with the adoption of the course in preparing a report of this kind. In the spirit with which he has approached the task Dr. Chree has shown, not only his devotion to his chosen science, but also his personal appreciation of the work done by those who obtained the observations, or made the observations possible, in the inhospitable regions of the Antarctic.

The general plan of the volume is similar to that of the one dealing with the earlier expedition. The first six chapters describe the reductions which lead to the monthly mean values, non-cyclic changes, diurnal inequalities (with Fourier coefficients), daily range, and daily maxima and minima of the magnetic elements; the rest of the discussion is on more individual and less standard lines. Dr. Chree devotes great attention to the important subject of the magnetic "activity"—its variations from day to day and from hour to hour, and its connection with other magnetic characteristics. He finds, for instance, that the remarkable differences existing between the Antarctic diurnal magnetic variations on quiet and on disturbed days are by no means merely proportionately intensified forms of the corresponding differences in temperate latitudes. Again, he investigates the tendency for a given state of magnetic activity to recur after twenty-seven days, a phenomenon long ago suggested by Broun and others, and independently established and brought into prominence more recently by Mr. Maunder. Dr. Chree uses his own admirable method based on daily character figures, and finds the tendency to be as clearly shown by the Antarctic as by the Kew records. The variation of the magnetic activity throughout the day, and even over short periods of an hour or so, has also been studied, the latter with the aid of the quick-speed records arranged to be taken simultaneously for "term hours" at the Antarctic and at many co-operating observatories. While these records have proved useful for the purpose named, Dr. Chree expresses doubt as to the desirability of including this arrangement in the programme of future polar expeditions.

Another subject discussed in much detail is magnetic disturbance of various kinds, including "sudden commencements," whether followed by a magnetic storm or not, large disturbances (studied from Antarctic and other records) and short-period disturbances. Some cases of the repetitions of disturbances at about the same hour on successive or adjacent days, such as were first noticed by Señor Capello in the Lisbon curves, were found in the Antarctic records, and are illustrated; it is to be regretted that the corresponding curves from other observatories were not obtained for these as well as for the larger disturbances discussed.

With the co-operation of Mr. C. S. Wright, an interesting chapter on the relation between auroræ and magnetic disturbance is included. In this chapter various definite numerical criteria are applied to test the view generally held that there is a close connection between the two phenomena. It is so difficult, on account of daylight, clouds and moonlight, to get records of auroræ at all comparable with the magnetic records in continuity or completeness that it requires some ingenuity to devise satisfactory numerical tests of the connection; Dr. Chree's tables succeed in confirming it, as they show that 41 per cent. of the "first-class" auroræ observed were associated with days of character-figure 2 (connoting a magnetically disturbed day), while no single aurora of the fourth class was so associated. It appears also that auroræ are probably rarely, if ever, totally absent, even at the times most quiet magnetically.

In order to utilise the results to the best advantage, Dr. Chree has not shrunk from entering upon enormous pieces of arithmetical computation, and the preparation of this report has been an enterprise which even those naturally most inclined towards numerical work might have shirked. The volume is necessarily restricted in its appeal, but magneticians will everywhere be grateful to Dr. Chree for the clear and accurate way in which he has ascertained and presented so many of the leading facts regarding the magnetic phenomena of the Antarctic.

The Analysis of Drugs.

The Chemistry and Analysis of Drugs and Medicines. By H. C. Fuller. Pp. ix + 1072. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 55*s*. net.

THE number of drugs in use at the present day runs into thousands, and each of them is a component of one or more, often many more, "medicines." The materials used as drugs include such diverse products as plants the constituents of which are unknown, elementary substances such as colloidal copper and sulphur, and complex but well-defined compounds like "salvarsan." To prepare a comprehensive account of the analysis of drugs and medicines is therefore a difficult task, and one may doubt Mr. Fuller's wisdom, but not his courage, in tackling it.

He has produced a book which is inclusive rather than useful, and is unnecessarily large, owing to faults in the arrangement of matter and to needless repetition; thus the assay of the principal crude drugs is described in chap. 2, and drugs which contain alkaloids or glucosides are discussed again in the chapters devoted to these constituents, with the result that the determination of morphine in opium is dealt with on pp. 53-60, and a second set of processes for this operation is given on pp. 211-13, a cross-reference being provided in neither case.

Many authors inadvertently repeat themselves, but it must be unusual to find such a case as that of saligenin in this book, which is described twice, each time under a central heading in heavy type on the same page (553), and a third time on p. 787; the headings are different each time, viz. "ortho-oxybenzyl alcohol," "salicyl alcohol," and "saligenin," but a chemist, with his daily experience of vagaries in nomenclature, should be prepared for such pitfalls.

In writing names of chemicals the conventional plan of writing all the parts of a name together—*e.g.* "acetylbenzoylaconine"—is sometimes adopted; at other times they are separated by hyphens, as in "Para-hydroxy-phenyl-ethylamine"; but occasionally they are disconnected completely, as in "Benzoyl Ecgonin."

The defects of the book are, unfortunately, not limited to matters of arrangement and nomenclature. Thus the jaborandi alkaloids are wrongly grouped with the derivatives of pyridine, and the attributions in some other groups are doubtful, whilst the alkaloids of physostigma and anhalonium should not be described as "of unknown composition." In the section relating to solanaceous alkaloids the information is given that "hyoscin, which was formerly reported as a naturally occurring constituent of henbane, has now been virtually relegated to oblivion." In spite of this it is resurrected four pages further on in the curious form "Scopolamin, hydrobromate (Hyosin)," and is apparently reconsigned to oblivion, since it fails to appear in the section devoted to scopolamine. Though *Hyoscyamus muticus* has probably been the chief source of atropine for more than twenty years, the only reference to it is as follows: "*Hyoscyamus muticus* is often offered for import as true *H. niger*." Cotarnine, in spite of its importance in medicine, is not mentioned, though each of the minor alkaloids of opium has a paragraph to itself.

The resin of podophyllum is described as containing both podophyllotoxin and picropodophyllin, whereas only the former is present, the latter being an isomeride formed by the action of alkalis. The section on Indian gum may include all that is known about this commodity in the United States, but it is misleading as regards the sources and character of this gum as it appears in European markets. In the portion relating to resins no attempt is made to deal critically with the numerous doubtful data published regarding the chemistry of these products; thus the formula $C_{20}H_{40}O_2$ is assigned to abietic acid, though it is described as containing hydroxyl, and is presumably a hydroxy-acid, while sandaracolic acid is mentioned as a constituent of sandarac, though the author of this acid withdrew it years ago.

Enough has perhaps been said to show that Mr. Fuller's book should be used with discretion. As it deals with nearly everything, including chewing gum, that has been used or can be regarded as a drug, and gives references copiously, it is at least a useful guide to the all too voluminous literature on the analysis of these products, though even in this respect it would be improved if the index were more complete and always strictly alphabetical. T. A. H.

South African and Indian Floras.

(1) *An Introduction to the Flora of Natal and Zululand.* By Prof. J. W. Bews. Pp. vi+248. (Pietermaritzburg: City Printing Works; London: Wheldon and Wesley, Ltd., 1921.) 15*s*.

(2) *The Flora of the Nilgiri and Pulney Hill-Tops.* By Prof. P. F. Fyson. Vol. 3. Pp. xviii+581. (Madras: Government Press, 1920.) 15 rupees 6 annas.

(1) THE volume by Dr. Bews, who is professor of botany in the Natal University College, Pietermaritzburg, was written mainly for the purpose of assisting students of plant ecology and those engaged in botanical survey work in Natal. The flora of that country received for many years the devoted attention of the late Dr. J. Medley Wood, who published among several other works a "Handbook to the Flora of Natal" in 1907, and a "Revised List of the Flora of Natal" in 1908, to the latter of which two supplements were issued. The Handbook is now out of print, and the Revised List is not easy to procure, while both are incomplete. Dr. Bews's work, therefore, supplies a need and will be welcomed. It contains 478 species of flowering plants that are not included in Wood's Revised List. Like Wood's Handbook it gives keys to the families and genera, short descriptions of the former, and enumerations of the species, with a few words on their distribution and here and there a native name; the Cryptogams are excluded entirely.

A very important omission from both Dr. Wood's Handbook and Dr. Bews's Flora is some means for the identification of the species. We realise that to have provided keys to the species would have increased the size of the volumes very considerably, but it would have made them infinitely more useful. Some of the Natal genera are rich in species; Panicum has 35, Schizoglossum 41, Indigofera 44, Crassula 49, Senecio 84, while Helichrysum has as many as 92. With the best of keys it is difficult to determine the specific name of a plant belonging to any large genus, but Dr. Bews affords no help at all in the matter.

While Dr. Bews's book will no doubt be of service to those for whom it was chiefly intended, it does not go far enough. Much had already been done on the plants of Natal, and it might reasonably have been thought that the time had come when a work of more general usefulness could have been produced. It may be mentioned that Dr. Bews has arranged the families in his book according to Engler and Prantl's system, and that he has followed the practice observed by zoologists generally and by certain botanists of using a small initial letter for all specific names.

(2) Volumes 1 and 2 of Prof. Fyson's work were published in 1915, and were reviewed in NATURE, vol. 96 (February 3, 1916), p. 615. These dealt with the flowering plants found above an elevation of 6500 feet around the hill-stations of Ootacamund, Kotagiri, and Kodaikanal. The present volume is supplementary, and includes the plants of the country around Coonoor above an elevation of 5000 feet.

The numerous outline drawings are an important feature in this volume as well as in the preceding; they certainly add considerably to the usefulness of the work, though, as they are full-page size, they have rendered it rather bulky and expensive. Notwithstanding that the text is in large, much leaded type it fills only 154 of the 599 pages in vol. 3; the other pages are used for the illustrations. These might have been reduced in size and the text might have been in smaller, less spaced type. By these means the matter in the three volumes could have been compressed into one. An admirable model might have been found in the late Colonel Sir Henry Collett's "Flora Simlensis." In Prof. Fyson's Flora we have another instance of the use of a small initial letter for all specific names. Whether this method of dealing with such names is advisable or not seems to be a matter of opinion; it has recently received some attention in the *Journal of Botany* (1921, pp. 159, 295-296).

Some additions and emendations in the volume under notice have been necessitated by the publication of Mr. J. S. Gamble's "Flora of the Presidency of Madras," of which the fourth part, carrying the work as far as the beginning of the Ebenaceae, appeared last August—too recent, therefore, for Prof. Fyson to have derived any assistance from it. He has been able to use Mr. Gamble's work only as far as the end of the Caprifoliaceae. It is probable, therefore, that the families from the Rubiaceae to the end will need some revisional treatment by Prof. Fyson, in order to bring his work into agreement with one that will be recognised for a long time to come as the authoritative Flora of Madras.

Science of Industrial Psychology

The Psychology of Industry. By Dr. J. Drever. Pp. xi+148. (London: Methuen and Co., Ltd., 1921.) 5*s*. net.

Industrial Fatigue and Efficiency. By Dr. H. M. Vernon. (Efficiency Books.) Pp. viii+264. (London: G. Routledge and Sons, Ltd., 1921.) 12*s*. 6*d*. net.

TWO entirely different methods of approaching the science of industrial psychology are represented by the two volumes under notice. Dr. Drever's book is an attempt to cover the whole field of industrial psychology, and to accomplish such a task in a book of 148 pages must lay itself open to the charge of being somewhat superficial. He devotes a short chapter to each of the sub-divisions of the science, and quotes, in a not too critical spirit, certain well-known experiments which have been carried out. These examples are mostly taken from the writings of American efficiency engineers, and, interesting as they may be, they are not sufficient to form the foundation of a whole science. They must be submitted to a much more critical examination than Dr. Drever gives them if they are to form even part of the subject-matter of the science at all.

Dr. Vernon's book is of a very different type. Its object is not to write an introduction to a science which at present is so young that any such attempt must concern itself mostly with saying what can be accomplished, rather than what has already been done. His book is an attempt to deal with one aspect of the science and concerns itself more with facts than theories, and for this reason alone is far more scientific than Dr. Drever's book. In his preface Dr. Vernon says, "I have not attempted to discuss scientific management for I have no first-hand knowledge of it, and, moreover, the subject is so large a one that it needs independent treatment. For similar reasons I have not attempted to deal with Vocational Selection in industry." This passage is really the keynote to the whole book, for although the author quotes copiously from the works of other writers in the same field, yet his main argument depends on the first-hand information which he and his colleagues have collected from the various factories they have visited. Throughout the reader feels himself in touch with reality rather than in the somewhat theoretic atmosphere prevailing in Dr. Drever's book.

It is true that Dr. Drever's object is somewhat different from that of Dr. Vernon, for he tells us that the book was written primarily to awake interest in the ordinary man, and so help to spread knowledge of the service psychology can render to industry. Even so it may be doubted whether it is wise to spread knowledge in the way Dr. Drever has done. Those who are working in this field of applied science have two great practical difficulties with which to contend. One is the ignorance or antipathy of the ordinary man as to the possibility that physiology or psychology can render any appreciable services to the problems of industry, and the other is that he sometimes expects great results with comparatively little effort on the part of the scientific worker. Dr. Drever's book undoubtedly does much to remove the first difficulty, but in so doing it does a great deal to increase the second.

A book that devotes a chapter of fourteen pages to intelligence tests, and then gives in an appendix a foot-rule for intelligence testing, is bound to give the impression that any one with a certain degree of intelligence but without any special knowledge is in a position to apply such tests with fruitful results. Any such impression is erroneous in the extreme, and pays little respect to the psychologists who are experimenting in this field of research and are trying to overcome scientifically some of the difficulties inherent in the subject, which are either not mentioned or passed over so lightly by Dr. Drever.

The fundamental difference between these two books is that the author of one is mainly interested in industrial psychology from the point of view of the lecturer; while the main interest of the author of the other is that of the research worker. Industrial psychology has a long way to go before it can offer much scope for those who wish to lecture profitably about its principles, for most of these have to be discovered by the research worker and tested in various fields before they can claim to rank as truly scientific. It is because Dr. Vernon has attempted this that his book marks a definite advance in the science and should be read by all who are interested in the human side of industry either from the practical or the scientific point of view.

Glacial Climates.

Das Klima des Eiszeitalters. By Prof. Dr. R. Spitaler. Pp. iv+138. (Prag: from the author, Smichow, 379. 1921.) 65K.

Dr Felix Oswald (Nature, vol. lxxv. p. 197) performed a remarkable feat when he printed his "Treatise on the Geology of Armenia" on a hand-press at Beeston in 1905. Prof. Rudolf Spitaler has reverted further, and has issued his work on glacial climates in a written script. The reproduction of this by lithography secures a uniformity that was not always possible among the ancients. He thus shows us a way out of the apparent *impasse* that has threatened scientific publication. The lodging in suitable libraries of, say, a hundred copies of a quarto memoir such as this would go far in the dissemination of ideas, and the process lends itself to tabular matter, freely used by Prof. Spitaler, and also to much delicacy of illustration. Authors in the days of imperial Rome were not dissatisfied with a manuscript mode of publication. The monumental "Naturalis Historia" of the elder Pliny, in thirty-seven books, gained a handsome circulation, and the author was engaged on a supplement—how well we know those supplements!—in the tragic year of 79. The genial Martial directs a would-be borrower to the shop of Attractus opposite Cæsar's forum, in the certainty that a copy of his latest poems could be bought there for five denarii. Allowing for the exchange, Prof. Spitaler asks little more, and we must remember that Roman publishers had the advantage of slave-labour.

In the beautiful script of his amanuensis, Prof. Spitaler supports the astronomical explanation of the climatic changes that produce or abrogate an ice-age. He divides the globe into zones of latitude, and shows how each would be affected by the variation of the perihelion position of the earth, combined with variation in the obliquity of the ecliptic. He lays stress on the distribution of land and water within the zones; climate is greatly affected by "continentality" and "oceanity." This, however (p. 29), does not account for the higher average temperature in January as against July at the equator, which is attributable to the occurrence of perihelion when winter reigns in the northern hemisphere.

A maximum excentricity of the orbit and a high obliquity of the ecliptic provide extreme conditions and promote glaciation; but Prof. Spitaler contends that even in these circumstances there need not be a reversal of the climate of each hemisphere every 10,500 years. He urges (p. 111) that a glacial climate, when promoted in the north, may affect the equator and still more the south, so that simultaneous glaciation over the whole earth, as postulated by A. Penck, is possible. Cool summers and mild winters (p. 94) favour snowfall, while hot summers and very cold winters are unfavourable. The maximum of the last warm period for the northern hemisphere (p. 57), when the summer took place in perihelion, is held to have occurred about 8500 years ago, an epoch that coincides presumably with the rapid melting back of the northern ice. The author (p. 131) looks forward to a continuance of a warm period, controlled by the excentricity, for nearly 500,000 years, when a great ice-age will again begin to affect the earth, unless tectonic changes intervene, such as have no doubt acted in the past. The Permian ice-age (p. 137) may be referred to the greater coolness of the large sea-area lying to the north of Gondwana Land, at an epoch of high excentricity, high obliquity of the ecliptic, with perihelion, as now, in the winter of the northern hemisphere.

In view of recent progress in physics, many geologists will prefer the hypothesis of variations in solar radiation as a possible explanation of great climatic changes; but this will not lessen their interest in Prof. Spitaler's detailed calculations.

G. A. J. C.

Our Bookshelf.

Capita Zoologica. Verhandelingen op Systematisch-Zoologisch Gebied. Onder Redactie van Prof. Dr. E. D. Van Oort. Deel I, Aflevering 1, *Nouvelles Recherches sur les Nématodes libres terricoles de la Hollande.* Par Dr. J. G. De Man. Pp. 62+14 plates. 10 guilders. Deel I, Aflevering 2, *Studien über Rhizostomeen mit Besonderer Berücksichtigung der Fauna des Malaiischen Archipels nebst einer Revision des Systems.* Von Dr. Gustav Stiasny. Pp. viii+176+5 plates. ('s Gravenhage: Martinus Nijhoff, 1921.) 16 guilders.

In these days of drastic economy it is becoming ever more difficult to find means for the publication of scientific work, especially when it has little or no direct bearing upon utilitarian problems. The systematic zoologist in particular has to content himself as a rule with as little as possible in the way of paper, letterpress, and illustrations, and it will probably be a long time before we see again in this country a series of zoological monographs comparable with that which embodies the results of the *Challenger* Expedition. Other countries, however, appear to be somewhat less embarrassed as to ways and means, and we are glad to welcome the appearance of a new Dutch periodical entitled *Capita Zoologica*, under the editorship of Prof. Dr. E. D. van Oort, Director of the State Museum of Natural History at Leiden. This publication will consist of a series of large quarto memoirs on systematic zoology, which will be issued separately as complete works as occasion requires. The first two are already published, dealing respectively with the free-living Terricolous Nematodes of Holland, by Dr. J. G. De Man, and with the Rhizostomatous Medusæ, by Dr. Gustav Stiasny. Both memoirs are fairly copiously, though by no means extravagantly, illustrated, and they form solid and valuable contributions to our knowledge of the groups with which they deal.

A. D.

Benzol: Its Recovery, Rectification, and Uses. By S. E. Whitehead. With an Introductory Note by the Rt. Hon. Lord Moulton. (The *Gas World* Series.) Pp. xiv+209. (London: Benn Brothers, Ltd., 1920.) Price 12*s.* 6*d.* net.

During the war the gas industry received a great impetus from the increasing demand for benzol and toluol for military requirements, and methods of recovery and production were adopted on a scale which was little appreciated at the time. One result of this was to pave the way for the foundation of a far greater benzol industry in this country than was previously existent, and the present volume has been written as a guide to the principles and practices engendered.

The text is most thorough, and while essentially practical, it does not ignore theoretical criteria cognate to the technicalities of the subject. The book is built up of exhaustive discussions of the recovery of benzol from gas, its rectification, and the uses to which it and the derivative products may be put. Probably the most interesting sections are those dealing with dyes, explosives, and the use of benzol as a motor fuel, which, although in the former connections modestly regarded by the author as summaries, are none the less useful and comprehensive. It is obviously important that, in view of this country's dependence on foreign resources of petroleum as a motor fuel, every effort should be made to ease the position by the establishment of a vast benzol industry, and in this effort the utmost encouragement should be given to those engaged in coal-gas production; the present volume is a valuable contribution to this end, and both for educational and technical purposes merits a wide circulation. H. B. Milner.

The Analysis of Mind. By Bertrand Russell. (Library of Philosophy.) Pp. 310. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Company, 1921.) 16*s.* net.

The title of Mr. Russell's book may raise expectations that it is an exposition or development of his philosophical theory. It cannot, however, take rank with his great works. It is a course of lectures, to all appearance a verbatim report, which has been subjected to the very minimum of revision. It is brimming over with casual witty remarks which pass well with an audience, but will not bear reflection. The lectures show Mr. Russell under the influence of two comparatively recent popular movements in philosophy and psychology, both of which seem to have attracted him powerfully, and neither to have convinced him completely, namely, William James's Neutral Monism and Prof. J. B. Watson's Behaviourism. One lecture deals at some length with the question, "Does Consciousness exist?" The answer reminds one of the famous pronouncement that Shakespeare's plays were not written by Shakespeare but by some one else of the same name. It is easy enough to argue that consciousness does not exist, but then there is something we are talking about when we affirm its non-existence, and it is difficult to find any other name for it. In regard to Behaviourism Mr. Russell thinks it a beautiful theory and an ideal method, but then—there are images, and the theory cannot account for them.

(1) *Aspects of Plant Life, with Special Reference to the British Flora.* By R. L. Praeger. (Nature Lover's Series.) Pp. 208. (London: S.P.C.K.; New York: The Macmillan Company, 1921.) 6*s.* net.
(2) *Mountain and Moorland.* By Prof. J. A. Thomson. (Nature Lover's Series.) Pp. 176. (London: S.P.C.K., 1921.) 6*s.* net.

There are many educated persons who are conscious that they miss much of the beauty and interest of the world around them through lack of knowledge and of the seeing eye that knowledge alone can give. To all such these two small volumes published by the S.P.C.K. will prove most acceptable. In an easy and non-technical fashion (1) Prof. Praeger sets forth the conditions under which various types of flowering plants exist, the problems by which they are confronted, and the devices by which they triumph. He brings forcibly to mind the deep philosophical nature of the questions that may be raised by the occurrence on hill or in valley of even the humblest plant.

(2) Prof. Arthur Thomson's book is a delightful companion for any one who wishes to enjoy intelligently a holiday among our moors and mountains. It touches in a stimulating and suggestive way on almost every branch of natural history in these favourite districts, and opens out numerous fields of research for the reader.

Practical School Gardening. By P. Elford and S. Heaton. Second Edition. Pp. 224. (Oxford: At the Clarendon Press, 1921.) 3*s.* 6*d.* net.

MESSRS. Elford and Heaton have had very considerable experience in organising school gardens and making them fit into the educational scheme, and they have produced a volume which has already proved its usefulness, so that it now passes into a second edition. The authors insist that the combination of School Gardening and Nature Study when properly co-ordinated with the rest of the work in the school can be, and often are, a valuable means of education. Most teachers would agree, but difficulties do undoubtedly arise when an attempt is made to put this excellent general principle into practice. Given a plot of ground, a class, and a limited but definite time each week, how is the teacher to proceed in order that the children may derive the maximum educational benefit? The practical details that need attention, the pests, weeds, and other troubles that are likely to cause trouble, and the many difficulties that crop up as soon as one begins to cultivate the soil, are effectively dealt with. The authors urge that a school reference library might with advantage be formed, but they give no suggestions to this end. In a future edition a list of suitable books might well be added.

Laboratory Manual of the Technic of Basal Metabolic Rate Determinations. By Dr. W. M. Boothby and Dr. Irene Sandiford. Pp. 117. (Philadelphia and London: W. B. Saunders Company, 1920.) Price 24*s.* net.

THE authors consider that the results of indirect calorimetry should not be thrown into general discredit as a means of clinical diagnosis, by neglect of details requisite for a true basal metabolic rate. In their well-illustrated book they have certainly set a good example in the matter of detail. They describe the method in use at the Mayo Clinic, Rochester, Minnesota. The patient inspires the atmospheric air through a mask, and the expired air is collected and measured in a gasometer (Tissot) from which samples of air are taken for analysis of carbon dioxide and oxygen by the Haldane gas analysis apparatus, the calculations being carried out as usual. The advantages of this method, and perhaps the disadvantages of other methods, are somewhat emphasised. The authors deserve credit for the very careful directions for all stages of the technique. The book contains a special note for calculation of metabolic rate of a diabetic, a bibliography, an appendix with all the tables required for calculations, and an index. Indirect calorimetry has certainly proved its value in cases of thyroid disease.

Some Account of the Oxford University Press, 1468–1921. Pp. 112. (Oxford: Clarendon Press, 1922.) 5*s.*

THIS is a charming monograph describing the work of a great institution. The book is a masterpiece of typography, and is embellished by a number of reproductions of old woodcuts and recent photographs. Special chapters are devoted to its most important publications—the Oxford English Dictionary and the Dictionary of National Biography. The vast operations of the Press may be judged by the fact that its warehouses at Oxford are estimated to contain 3½ million copies of about 4500 distinct works. From these vaults was drawn into the upper air, in 1907, the last copy of Wilkins's "Coptic New Testament," published in 1716, the paper scarcely discoloured and the impression still black and brilliant. During the War, the Press carried out much confidential work for the Naval Intelligence Department, and supplied during three years 4½ million copies of the New Testament for use in the field. The relations of the Press to its servants have always been amicable, and the case of the late Mr. J. C. Pembrey, one of the proof-readers, is probably unique: in 1847 he read Wilson's "Sanskrit Grammar," and in 1916 the "Vedic Grammar" of Prof. Macdonell.

Animal Life of the British Isles: A Pocket Guide to the Mammals, Reptiles, and Batrachians of Wayside and Woodland. By E. Step. (The Wayside and Woodland Series.) Pp. vii+184+111 plates. (London and New York: Frederick Warne and Co., Ltd., 1921.) 10*s.* 6*d.* net.

THIS handy little volume will be welcomed by a large number of amateur naturalists, and can be cordially recommended to all who wish for full and accurate knowledge of the habits, life histories, and appearances of those members of the British fauna that are included in the three classes specified in the sub-title. Hitherto it has not been possible to secure such information within the covers of a single small volume, nor in any one work at so low a price. The illustrations are excellent, the plain being from the work of our best naturalist photographers, such as Messrs. Douglas English, Oxley Grabham, and others, while forty-eight photographs in the natural colours are to the credit of Mr. W. J. Stokoe. The co-operation of these talented artists with the author results in a very satisfactory pocket guide.

British Insect Life: A Popular Introduction to Entomology. By E. Step. Pp. 264+32 plates. (London: T. Werner Laurie, Ltd., N.D.) 10*s.* 6*d.* net.

ATTEMPTS to give "popular" accounts of the several orders, families, and other subdivisions into which insects are classified almost invariably fail from lack of the courage needed to set before the general reader those details of structure that must be mastered in order to discriminate order from order, genus from genus, and, still more, species from species. In the absence of such information books such as this by Mr. Step become, except to those already versed in entomology, meaningless in many of their pages. We should welcome statements which would enable the enthusiastic beginner to determine whether the specimen in his hand was, say, a stone-fly, a may-fly, a lacewing-fly, or a caddis-fly; and others rendering clear the structural differences between, say, the pierid and the nymphalid butterflies; and so on. We decline to believe that shirking the difficulties will ever popularise or in any way benefit the science of entomology. The figures in the plates of this book are unfortunately not numbered; thus the uninstructed reader is left in doubts as to the application of the numbers given in the respective legends.

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.*]

Mind.

THERE seems to me now to be some prospect of agreement that, since all characters are equally products of nature (potentiality, capacity, predisposition, diathesis) and fitting nurture, all must be equally innate, acquired, germinal, somatic, and inheritable. *If* that be the case, the problem of inheritance is settled. Doubtless some biologists will continue to discuss such things as the transmission of characters and the intensity of inheritance, but the impossibility of defining their terms and explaining what they mean will always vitiate their labours.

Whatever other tasks biology has before it, two are of prime importance: (*a*) to determine what characters are evoked in individuals by such influences as food, moisture, light, temperature, hormones, use, injury, and the like, and (*b*) to trace the evolution of races, which implies tracing the changes in their natures (*i.e.* in germ-plasms as indicated by changes in characters), which, since the nature of every race is the sum of its potentialities, in turn implies tracing changes in potentialities for development. In both these tasks biology must seek its data from the subsidiary sciences of physiology and psychology.

The kinds of nurture with which we are most familiar, and which we can most easily observe in action, are injury and use. Here, therefore, we are best able to note to what extent individuals are capable of developing in response to given influences, and to what extent species have altered with respect to their capacities for development. Both injury and use confer adaptability on the individual. Injury need not detain us long. Many plants and some lower animals are capable of developing greatly in response to it. Thus a begonia or a sponge may be completely regenerated from a fragment. A lobster can regenerate its claw and a lizard its tail. Higher animals merely heal injuries by means of scars. In them this capacity has undergone retrogression and has been replaced (or supplemented) by that which confers much more adaptability—the capacity of developing in response to use.

It would seem that the power of developing in response to use is a late and a high product of evolution. At any rate, since it is inappreciable in low, and progressively more evolved in higher, animals, presumably it must have had a beginning somewhere in the scale. Presumably also, since a structure cannot be used before it exists, the individual recapitulates in this particular, as in others, the evolution of his race.

The evidence is much clearer as regards mind. I take it that mind is associated with movement; its function is to cause the individual to take action. A reflex action may be associated with consciousness. Some reflex actions (*e.g.* sneezing) are even initiated by consciousness. Some (*e.g.* breathing) can be controlled to some extent by the will; but no reflex action is *initiated* by the will. Thus, when we cough at will the action is not reflex. Reflex actions, therefore, may be defined as those which are initiated by stimuli other than will. On the other hand, an instinct is always and altogether a mental thing—a mental impulse, an emotion, an inclination, a desire to do a certain action, the instinctive action. Like reflexes, it develops in the individual apart from mental experience which merely awakens it to activity, but does not create it. In other words, an instinct is not learned; it is not a product of the functional activity of the mind, but develops in response to quite different influences (*e.g.* hormones). It is not a complex reflex; some reflex actions (*e.g.* sneezing) are quite as complex as some instinctive actions (*e.g.* infantile crying). An instinctive action differs from a reflex action in that it is always *voluntary*. The individual performs the action because he *wants* to do so. If there were no desire, there would be no action. I am aware that all this is unorthodox. Nevertheless, it is true, as any one may discover by examining his own instincts. Does he not, for example, eat, and drink, and sport, and make love through desire? Did he *learn* to feel these desires? I am aware also that at this stage it is customary to discuss the metaphysics of mind and will. I have tried to do so elsewhere, but it is unnecessary here. It is enough that mind, including will, exists and appears to influence the body as gravitation appears (as incomprehensibly) to influence the planets. Instinct may be defined as desire which develops in response to influences other than functional activity.

Habit, intelligence, and reason are in a different category. They are all products of learning, of mental growth due to the functional activity of the mind. An animal is intelligent in proportion as it profits mentally from experience—that is, in proportion as its past sheds a light on, and serves as a guide for, its present and its future. The animal then stores experiences and *re*collects them. Thus its mind grows. We have given a special name to the power of growing mentally in response to use, though the word is used somewhat vaguely. We call it memory. We speak of a man with a good or bad memory, with good or poor powers of learning.

There are two sorts of memory, conscious and subconscious. Again I am unorthodox, but my words have real meanings. We learn two sorts of things: (*a*) facts and the like, which we can recall to mind and which belong to the conscious memory, and (*b*) skill and facility in thinking and doing (mental habits) which cannot in the same sense be recalled, and which, therefore, belong to the subconscious memory. For example, I can recollect a good deal about golf clubs, balls, courses, and adventures; but all this is quite distinct from other sorts of learning, which I cannot in the same sense recall, and, therefore, cannot describe, which enable me to play skilfully (to a humiliatingly small degree). The greatest golfers do not know the very names of the muscles which they have learned to co-ordinate with such exactness and facility.

Consider the caterpillar. He comes out of the egg and, equipped with instincts, at once sets about the business of life. He seeks his food and devours it; he hides from enemies; at the proper time and place he builds a cocoon, and as a butterfly does all sorts of new actions of which also he can have had no previous experience. Apparently he learns nothing; he has little or no memory. Learning would be useless to him; for, unprotected and untaught as he is, he must always act correctly and at once, or perish. He can "bear in mind" for a little while, as a sound lingers on a harp-string. But he cannot recall, as a sound is reproduced by a gramophone. He can feel (*e.g.* pleasure and pain, desire and aversion), but he cannot think (compare, associate, imagine, and the like); for without learning he has nothing to think about. Because his past is a blank he cannot forecast his future, which, therefore, is a blank also. He lives only in the immediate present—a knife-edge of time. Since he has little or no power of profiting by experience, he is not adaptable; he moves in much the same groove as did his ancestors of a million years ago.

Higher than the caterpillar in the animal scale, the power of growing mentally in response to functional activity is clearly in being. Animals are able to recognise mates and offspring, and the latter are able to recognise their guardians. Family life begins. The offspring, more or less helpless at birth, but protected by their guardians, have ability and opportunity to develop physically and mentally in response to functional activity until they are able to fend for themselves. They begin to think, they become adaptable. This evolution culminates in man, who is born so helpless that he cannot even seek the breast, but who learns so enormously that he becomes rational. Reason is merely intelligence *in excelsis*. A vast and complex store of experience then lights a complex, and perhaps distant, future. Compare three human individuals—an idiot, a newly born baby, and a normal man. The idiot cannot learn, and has not learned; the baby can learn, but has not learned; the normal man can learn, and has learned. There in a nutshell is all the mental difference between them, except that the baby has not yet developed a few instincts. The idiot has these instincts, but, probably because he has lacked some hormone, has reverted by mutation (himself or by some progenitor) to an enormously remote ancestry in which the power of learning was defective. One day I think we shall cure idiocy by the injection of the proper glandular extract. Compare a man with a dog: how enormously greater is the human power of learning, and, therefore, of thinking. Compare him with a housefly: the fly settles on the hand; we strike at it; impelled by instinct, it shoots away; a moment after, having ceased to "bear in mind," it is back again, unmindful of a danger the recollection of which would set a man shuddering for years. We are able to domesticate animals only when they have the capacity to learn to tolerate, to obey, and, when the intelligence is very great (*e.g.* dog), even to love us. Savage man is so intelligent that he has invented language by means of which he is able to hand on the accumulated traditions of generations. Civilised man differs from him in that he has invented aids to his powers of remembering (*e.g.* books of reference), of thinking (*e.g.* mathematics), and of doing (*e.g.* tools). The retrogression of instinct and its replacement by intelligence is well illustrated by maternal care among brutes and men. Among the former it is instinctive, but women have to learn how to tend their young. Again, while insects walk instinctively, men learn. Among the higher animals the number of offspring is controlled by the number which can be protected and taught.

This or that naturalist may disagree as to this or that detail of what I have written about mind, but with the main argument I think all must agree. Already, in practice if not in theory, actions which are not initiated by the will are called reflex; those which are initiated by the will, but in which learning plays no part, are called instinctive; while those which are both initiated by the will and result from learning are called intelligent. As to the evolution of the potentiality of developing in response to use, the truth is glaringly obvious. Even a schoolboy knows that he can teach a beetle nothing, a cat a little, a dog more, and a child much. But all this is incompatible with Lamarck's first law, which has met with such general acceptance. As regards body, the evolution may be more difficult to trace. At any rate, it has not been studied. But as regards mind it is as clear as sunlight. Plainly, an animal is intelligent in proportion as it is able to profit from experience; man's reason and intellect depend wholly on his power of learning; and, as well as I can judge, whenever an animal is capable of learning it is also capable of developing physically in a corresponding degree in response to the stimulus of use.

G. ARCHDALL REID.
9 Victoria Road South, Southsea, Hants.

Pencil Markings in the Bodleian Library.

IN a former communication (NATURE, 1920, vol. 105, p. 12) I described a method of distinguishing microscopically between the markings made upon paper with different kinds of pencils, and gave some account of the characteristics of early pencil writings in the British Museum.

I am now indebted to the Librarian of the Bodleian Library and to Dr. Craster for their kindness in giving me facilities for studying similar early specimens of pencil writing in that library.

In Schönemann's work on the examination of early MSS. ("Versuch eines Systems der Diplomatik," 1818, vol. ii. p. 108) it is stated that the ruled lines in various documents of the eleventh and twelfth centuries are in a graphite pigment. Referring to this statement I pointed out (*loc. cit.*) that, since graphite was only discovered in 1560, it was obvious that Schönemann must have mistaken ordinary metallic lead for graphite.

The historical basis for my criticism is to be found in Gesner's "De Rerum Fossilium Lapidum et Gemmarum Genere," 1565, vol. ii. p. 105, and in Beckmann's "Beiträge zur Geschichte der Erfindungen" (1780). It appears, however, that graphite must have been known long before that time, for, after reading my communication, Prof. Flinders Petrie informed me that he had discovered a lump of graphite at Ghorub, which must have dated back to a period between 1500 and 1200 B.C., although there was no evidence that graphite was ever used as a pigment in ancient Egypt.

This unique specimen of graphite, a portion of which Prof. Flinders Petrie has kindly given me for examination, is a decidedly coarse, impure mineral, containing only 39·4 per cent. of carbon, and the amount of silicious impurities present is plainly indicated by the pronounced irregular striations in the markings on paper.

This proof that graphite was known ages before its reputed discovery in 1560 in the Borrowdale mine, gives an added interest to the examination of the earliest pencil markings available in this country.

The earliest known instance of pencil marking in the Bodleian is a vellum MS. Commentary on the Book of Job of the thirteenth century (Auct. D. iii. 14). This has vertical lines, ruled with a stylus down the sides of the writing, and the microscope shows that the pigment of these is lead or other metal.

In the "Opuscula Varia SS. Augustini et Bernardi" of the thirteenth and fourteenth centuries (Hatton MS. 102), the ruled lines surrounding the text are in a red ink in some of the MSS., whilst in others they are in a metallic pigment. In another Hatton MS. (No. 107) of the fourteenth century, no pencil markings are present, the ruled lines at the side and the annotations being in a pale brown ink.

The "Opera Johannis Dastyn" of 1590 (Bodl. MS. 485) is written in ink, and shows pencil strokes at the side written in graphite, but there is no evidence that these markings were contemporaneous with the body of the MS.

An Italian MS. on paper, "Geomantia" (Digby MS. 133), written in ink prior to 1634, shows fine ruled lines at the side in a brilliant metallic pigment;

and the annotations in a Hebrew MS. "Jad Chazaka" (Poc. 235) of about 1650 are also in lead or a lead alloy.

The notebook of the Swiss scholar Casaubon, (Casaubon MS. 61), written about 1613, is particularly interesting. The leaves of the book are of thick horn and are covered on each side with minute writing, which is in a metallic pigment, showing much finer spicules than is usual in the writing done with a metal style. It resembles the pigment used in the drawings of the Stowe MS. "Arms of Ancient Nobilitie" of the early seventeenth century (British Museum).

A series of almanacs interleaved and containing Anthony Wood's Diary from 1676 to 1685 (Wood's Diaries 20–29, 742), shows ruled lines in a metallic pigment, while the entries in the diaries are either in ink or, less frequently, in pencil. Referring to the latter entries, the Rev. Andrew Clark remarked ("Life and Times of Anthony Wood," I. 3 Oxf. Hist. Soc., 1891): "Wood's pencil, I assume, was not graphite, but actual lead. It has left a faint mark, almost illegible, except for the indentation of the paper." Microscopical examination of these entries down to 1685 showed that this assumption was correct, none of the writing having the characteristics of graphite.

At a later date, however, Wood appears to have had a graphite pencil. "A Collection of Poems on Affairs of State," London, 1689 (Wood, 382) has a note on its flyleaf in the writing of Wood: "Bought at Oxon. 26 Feb. 1688." (The discrepancy between the dates is explained by the use of the old style for one of them.) This writing has the appearance of ordinary graphite, the masses of black pigment being uniformly distributed, and none of the particles showing the lustre or striation of lead or its alloys.

With the very doubtful exception of the markings in the MS. of Johannis Dastyn (*supra*), this is the earliest writing in graphite pencil noted in the Bodleian Library.

It will be recalled that the earliest graphite writing found in the British Museum was in two Notebooks of Sir Thomas Cotton, one of about 1630–1640 and the other 1640–1644.

C. AINSWORTH MITCHELL.

195 Victoria Street, S.W.1.

Haloes and Earth-History: A New Radioactive Element.

IN the Archæan black mica of Yitterby, very small, colourless, spherical, halo-like forms occur. The mica is, as it were, bleached within these halo-spheres. Many show a central opaque particle or nucleus. In the case of others it is difficult to be sure of the presence of a nucleus, or it may take the form of a limpid refracting particle. The optical appearances suggest that in these spheres the refractive index of the mica has been raised.

They are very small. A cluster of these minute haloes, amounting to many hundreds, presents with a low power the appearance of a starry sky. The average diameter appears to be 0·01 mm., no allowance being made for the nucleus. The greater number are remarkably uniform in diameter. Thus, readings of 23 of these haloes, taken at random, range from 50 to 59 scale divisions of the micrometer. A few larger ones are present, but, as in most cases their greater size is directly referable to an aggregation of nuclear particles occupying a large central volume, it seems safe to conclude that these limpid spheres are in reality of one size only.

The mica flake in which this cluster occurs is 0·018 mm. thick, or perhaps a little less. The minute spheres are located at various depths in the mica—some below the surface, some more or less truncated. Many are sharp and easily measured; others, as would be expected, are diffuse upon the edge.

I have been for some years aware of the existence of these haloes—since a period before the war—but, during the occupation of my laboratory by troops in 1916, among other things lost was the specimen of Yitterby mica from which my slides were obtained. A few other samples of this mica did not appear to contain them. Nor could I form any probable theory to account for them. Their uniform size convinced me that they were radioactive. The hypothesis that they might be due to slow β-radiation had really nothing to support it: no similar effect having been found in any other mica. Later I concluded that they must be reversed haloes such as I found in the Devonian mica of Co. Carlow. There were other appearances to support this view. Thus in the very similar Archæan mica from Arendal, bleached uranium haloes in various stages were found. Again, in both the Yitterby and Arendal mica, semi-bleached bands occur having a centrally placed line of what are probably radioactive particles disposed like a central moraine on a glacier. But with these appearances of reversal were vigorous haloes in all stages of development.

Recently, Dr. Prior was so good as to send me some flakes of Yitterby mica. In them I found all the appearances described above, including a few of the minute bleached halo-spheres.

The idea that this bleaching of the Archæan micas might be due to former high temperature conditions led to a test of the behaviour of the Carlow mica at different temperatures. It was found that a halo-rich specimen of this mica after an hour's exposure to a temperature of about 730° C. had acquired many of the characters of the Archæan micas. Most of the haloes had disappeared, and some had left a bleached area giving quite characteristic readings. Bleached bands, also, had taken the place of linear radioactive staining; and the originating radioactive particles were exposed to view forming a central line.

There is, I think, no doubt that these (and other) appearances show that the Yitterby and Arendal Archæan micas were at some remote period subjected to a temperature probably not much exceeding 700° C. during which a prior-existing crop of haloes were obliterated or reversed, and that, therefore, the existing haloes are a second crop which originated from the same nuclei when the thermal conditions permitted their development. This history has a good deal that is fortuitous connected with it. Some three hundred additional degrees of temperature would have reduced the mica to a slag.

But what is to be inferred as to the nature of the minute halo-spheres? A chance find seems to bear upon their origin.

In the mica of Arendal uranium haloes are fairly abundant; they occur in every stage of development. Within some of the earliest rings having radial dimensions reading from 0·0150 to 0·0160 (corresponding to rings which in Devonian mica read 0·0145) a very minute ring is sometimes seen. It is a difficult object and needs good lighting and good sight to detect. This ring surrounds the point-like nucleus with perfect centricity, an intervening band of unstained mica being apparent. The radius of this ring has been read from 0·0049 to 0·0057. The effect of the nuclear dimensions on a ring so small is considerable. I make no correction for it here. Presumably we are dealing with an α-ray of the same range as that which must have been concerned in the genesis of the Yitterby haloes.

This range, if taken as 0·005 mm., would correspond to about 1 cm. in air at 15° C. The radioactive element concerned, although associated with the uranium family of elements in the Arendal mica, cannot be a member of that family. This appears from the value which in such a case we must ascribe to λ. It would decay at a rate some billions of times slower than uranium according to an exterpolation on the Geiger-Nutall curve. Now the ring in the Arendal mica must have been formed since early Archæan time and from a nucleus of point-like dimensions.

From all this there seems good evidence that a radioactive element exists (or formerly existed) emitting an α-ray having a range of about one centimetre in air. So far no evidence of its further disintegration has been found.

It seems probable that the development of the small Yitterby halo-spheres represents a very considerable period of time. It will be of interest to see if similar evidence for what appears to be a very long period of Earth-history, seemingly preceding early Archæan time, will be forthcoming from material found elsewhere. It is possible that this period preceded the thermal conditions which generally prevailed during Archæan time and that the survival of the evidence contained in the Yitterby mica was due to local fortuitous conditions. These haloes would, in that case, be a record carried from one geological age to the next.

I wonder am I justified in naming an element from such evidence as I have found—the range of an α-ray? I think it has been done before. If ever it is isolated I would ask the finder to call it Hibernium after this beautiful but most unhappy country.

J. JOLY.

Trinity College, Dublin, April 8.

The Helmholtz Theory of Hearing.

ON a visit to the Cambridge Physiological Laboratory not long ago Dr. Hartridge demonstrated an apparatus of his design that showed the effect of a repeated sinusoid vibration on a series of pendulums of different periods. Each of a series of weights was suspended from a horizontal bar. The strings were all of different lengths; each pendulum had thus a different period. The horizontal bar was connected with a wheel so that it could be moved back and forth harmonically.

When the wheel was started, all the pendulums began to vibrate. As the wheel continued its rotations, the pendulums gradually came to rest—except one, namely, that one the natural period of which corresponded with that of the rotating wheel. This proved that with a continuous series of vibrations only a pendulum with a harmonic period would be maintained in vibration. It also proved that a single vibration set *all* pendulums in vibration no matter what natural periods they might have. Dr. Hartridge has thus demonstrated that if the ear possesses a series of resonating organs *every one* will respond to the first vibration and will come to rest only when this vibration has been several times repeated.

When a person sings a glide from one note to another, his voice produces vibrations that are all different. Every one of these vibrations is the first of its kind, and at no moment is there a succession of waves of the same period. Consequently at every single vibration *all* the resonators in the ear are set in vibration, and this vibration of all of them continues throughout the glide. In speech the voice is never still for an instant. Every vibration from the larynx differs from the one before. Therefore in perceiving speech *every* resonance organ of the ear must act at every instant for every vibration of the voice.

Dr. Hartridge has given a complete and final proof that, if the ear possesses a set of resonating organs, they must all respond together for each new vibration; as the changing tone of speech has a new vibration at every instant, they must all respond alike at every instant and for every tone.

According to the Helmholtz theory each vibration acts on a different resonator in the ear. In the sliding tone always used in speech each single vibration must, according to Helmholtz, pick out a corresponding resonator. It is easy mathematically to show that this cannot be true and that each single vibration of the voice in speech must set all resonators in action. Nobody seems to have thought of this, and it has remained for Dr. Hartridge's highly ingenious apparatus to kill finally the Helmholtz theory of hearing.

In the April number of the *British Journal of Psychology*, Dr. Hartridge gives as the fundamental reason for supporting the Helmholtz hypothesis that the experiments described by him show that there are resonators somewhere. As pointed out above, they show exactly the opposite, namely, that there cannot be any resonators anywhere. If there cannot be any resonators, then the hypothesis that the ear acts as a resonating apparatus becomes an impossible one.

E. W. SCRIPTURE.

Boyle's Experiments on Capillarity.

IN Mr. Hardy's interesting "Historical Notes upon Surface Energy and Forces of Short Range," NATURE, March 23, p. 375, he says that "Boyle tried, but failed, to observe whether the (capillary) rise took place in a vacuum." Boyle writes in Experiment XXXV. of the "New Experiments Physico-Mechanical" that after showing the capillary rise in open air, "We tried indeed, by conveying a very slender pipe and a small vessel of water into our engine (air pump receiver), whether or no the exsuction of the ambient air would assist us to find the cause of the ascension we have been speaking of; but though we employed red wine instead of water, yet we could scarcely perceive through so much glass, as was interposed betwixt our eyes and the liquor, what happened in a pipe so slender, that the redness of the wine was scarcely sensible in it. But, as far as we could discern, there happened no great alteration to the liquor; which seemed the less strange, because the spring of that air, that might depress the water in the pipe, was equally debilitated with that, which remained to press upon the surface of the water in the glass." Boyle was a very careful and accurate experimenter, and he was trying to find whether there was an alteration in the capillary height *in vacuo*. His experiment was quite accurate and is worthy of his great reputation.

SIDNEY SKINNER.

South-Western Polytechnic Institute, Chelsea, London, S.W., April 6.

Problems in the Variability of Spectra.[1]

By Prof. THOMAS R. MERTON, F.R.S.

IT has been known for many years that the radiations which an element emits in the state of a luminous gas are not invariable but depend on the presence of other elements, the manner in which the substance is excited to luminosity, and other circumstances. It was recognised in some of the earliest investigations that many band spectra were to be associated with compounds and that a spectrum might be due partly to such compounds and partly to uncombined atoms. Thus, for example, if strontium chloride is introduced into the flame of the bunsen burner we find lines associated with the element, bands due to strontium oxide, and also bands due to the chloride, and when strontium bromide is substituted for the chloride the spectrum is the same as regards the lines due to the element and the oxide bands, but bands peculiar to the bromide are found to have replaced those due to the chloride.

Minute quantities of substances can sometimes be detected by means of these characteristic bands due to compounds, a familiar example being the blue flame which is seen when common salt is thrown onto a coal fire and is due to the copper chloride formed from the chlorine in the common salt, and the minute trace of copper which is present in the coal. A number of different elements are present in most flames, and the reactions which occur are probably very complex. In gases contained in vacuum tubes which are excited to luminosity by electrical discharges it is possible to work with pure substances, and a discussion of the spectra observed is simpler.

In the case of gases in vacuum tubes the spectrum sometimes consists of bands, and the band spectrum from the negative pole may be different from that seen in the positive column. Thus nitrogen, when excited by uncondensed discharges, shows in the visible regions two band spectra, one known as the positive band spectrum, which appears in the capillary of a vacuum tube of the conventional type, and the negative band spectrum, found in the neighbourhood of the cathode, which constitutes an important part of the spectrum of the aurora.

Both these band spectra, and indeed all band spectra, are generally attributed to molecules rather than atoms, but if a condensed discharge is passed through nitrogen the spark spectrum associated with the nitrogen atom is obtained, and this is capable of further modification when discharges of great intensity are employed. The action of the condensed discharge is almost certainly due to the greatly increased current density which obtains during the very brief periods while the discharge is passing. Its first effect is to break up the molecules into atoms, and the further stages brought about by an increase in the intensity of the discharge are generally supposed to be due to the removal of successive electrons from the atoms. There are other methods by which the current density can be increased with similar changes in the spectrum; the effect of an increase in the current density is to increase the number of charged particles in a given volume of the gas, with the result that a large number of the radiating atoms are subjected to intense electric fields due to neighbouring charged particles.

Similar results are observed in the spectra associated with carbon. There are at least six spectra due to compounds of carbon with hydrogen, oxygen and nitrogen, and special experimental conditions are necessary for the production of some of these spectra. In addition to these band spectra carbon shows line spectra, and with the most intense discharges which can be employed in the laboratory a number of new lines appear which are also found in the spectra of the hottest type of stars, known as the Class O, or Wolf-Rayet stars.

All these changes can be reasonably accounted for, but there are a number of other changes which are more difficult to explain. For many reasons the spectrum of hydrogen is of particular interest, because the atom of hydrogen is the simplest known atom and is supposed to consist of a positive nucleus and a single electron. There are two spectra associated with hydrogen, one of which, the Balmer series, is found in almost all celestial spectra and also in vacuum tubes in the laboratory unless the most rigorous precautions are taken to exclude all traces of hydrogen. The explanation of the origin of this spectrum has been one of the most striking successes of the quantum theory of spectra developed by Bohr and by Sommerfeld. The other spectrum of hydrogen, known as the secondary spectrum, consists of an enormous number of lines and differs in its mode of production from the Balmer series in that the secondary spectrum is characteristic of pure hydrogen. In the purest hydrogen obtainable the secondary spectrum may be as bright as the Balmer series, but if the smallest trace of impurity is present the Balmer series gains in intensity and the secondary spectrum becomes very much weaker. In a vacuum tube containing water vapour the lines of the Balmer series are extremely intense whilst those of the secondary spectrum are relatively very faint. The investigations of Michelson and Lord Rayleigh, and of Buisson and Fabry have shown that under certain conditions the masses of the atoms or molecules from which the spectrum originates may be deduced from a knowledge of the widths of the spectrum lines, and recent investigations, in which the widths of the lines of the secondary spectrum of hydrogen have been measured to a high degree of precision, have shown that the secondary spectrum is to be referred to the hydrogen molecule.

The presence of impurities in vacuum tubes containing hydrogen not only enhances the lines of the Balmer series but also brings about changes in the relative intensities of the Balmer lines themselves. Some of these changes are very striking, but there are other variations of a more subtle kind which are only discovered when accurate quantitative measurements are made of the relative intensities of the lines. A most striking effect is observed when a relatively large quantity of helium is admitted to a vacuum tube containing hydrogen. Under these conditions the

[1] From a discourse delivered at the Royal Institution on Friday, March 10.

relative intensities of some of the lines of the secondary spectrum alter in a surprising manner, some of the lines being greatly enhanced whilst others become very weak.

From a theoretical point of view the spectrum of helium is second in importance only to that of hydrogen. The lines of helium are prominent in the spectrum of the chromosphere of the sun and of many stars, and their relative intensity varies under different conditions of excitation in the laboratory and in different celestial spectra. There are six chief series of lines in the spectrum of helium, three of which are usually referred to as the "helium" and three as the "parhelium" series. The helium series are the stronger in vacuum tubes containing the gas at pressures exceeding a few millimetres, whilst at very low pressures the parhelium series are predominant. Since the chief visible line of the helium series is yellow and that of the parhelium series green, the colour of the discharge is changed from yellow to green when the pressure is reduced.

There is another spectrum associated with helium which is analogous to the secondary spectrum of hydrogen in that it appears with any considerable intensity only when the gas is exceedingly pure. This spectrum is known as the band spectrum of helium, and its occurrence in a gas which is known to be incapable of forming molecules in the chemical sense of the word is very remarkable, in view of the fact that band spectra are generally attributed to molecules. It may perhaps be suspected that there is some temporary association of atoms during the passage of the electric discharge which cannot be referred to as a molecule in the chemical sense of the word. Prof. A. Fowler has shown that the arrangement of the heads of the bands in this spectrum resembles that found in series of lines which are due to atoms, though the arrangement of the lines which constitute each band is of the type usually found in band spectra.

When powerful condensed discharges are passed through helium a spark spectrum is developed. Two series in this spectrum are known as the 4686 and the T Puppis series, and their discovery by Prof. Fowler has led to some of the most important developments of theoretical spectroscopy. These spark lines of helium are found in the nebulæ and early type stars, and are attributed to helium atoms which have lost an electron.

The energy required to produce spark spectra varies widely with the nature of the gas under investigation, and for elements of the same chemical group is, as a rule, smaller the greater the atomic weight of the element. Thus in the case of helium powerful discharges are required for the production of the spark spectrum and the lines of the arc series are always bright. In the case of argon a much less intense discharge is required to produce the spark lines, and with very powerful discharges the arc lines disappear almost entirely from the spectrum. In addition to the production of these spark spectra one of the effects of powerful condensed discharges is to alter the relative intensities of the arc lines. Generally speaking, the effect of an increase of energy on a particular series of lines is to enhance relatively the more refrangible members of the series, but the effect varies in degree for different series. Experiments of this kind enable us to imitate to some extent in the laboratory the distribution of intensity amongst the lines which is found in the nebular and stellar spectra.

It will be seen that whilst many variations in spectra can be referred to different compounds, to molecules, and to uncombined atoms in successive stages of ionisation, there are a number of other changes for which there is at present no obvious theoretical explanation. The possibility of some specific influence of one gas on the spectrum of another must now be recognised apart from the formation of chemical compounds, which, in the action of helium on the spectrum of hydrogen, for example, appears to be excluded. There is also other evidence, based on a study of the broadening of spectrum lines, of a specific action on neighbouring atoms. We are still awaiting a satisfactory theoretical explanation of phenomena of this kind, though it is now forty years since what is perhaps the first known example, the action of sodium on the absorption spectrum of magnesium vapour, was observed by Prof. Liveing and Sir James Dewar at the Royal Institution.

Mathematics and Public Opinion.

PERHAPS few well-known mathematicians have escaped an experience which would be amusing if it were not so exasperating. Mr. Brown (let us say) is introduced to Prof. Smith, who teaches mathematics at a provincial college. After the usual expression of pleasure at the introduction, Brown generally adds "Of course, although I haven't had the pleasure of *meeting* you before, I know you well by reputation." Then, without so much as pausing to take breath, he proceeds to explain that he was always a duffer in "maths" at school, and that he has now forgotten everything about the subject they tried to teach him as a boy. Now Brown doesn't act in this way to every celebrity. If introduced to Dr. Lasker, and unaware that he is a distinguished mathematician, he does not seize the first opportunity of telling him that, although he occasionally plays draughts with his wife in the evening, chess was always beyond him, and he could not remember the simplest openings. Still less does he act in this way if his new acquaintance is a sportsman or an epicure. Moreover, in making his lamentable confession, Brown shows no sign of regret or humiliation; on the contrary, a sort of satisfied look steals over his face, suggesting that he is glad to be free once for all from the study of such a repulsive and useless subject. England is perhaps the only country where such an occurrence is fairly frequent; and this fact suggests some very unpleasant reflections.

One thing clear from Brown's attitude is that he evidently fears lest Smith should introduce some mathematical topic during the conversation. Of course this is the thing Smith is most unlikely to do. If this were all, it would be as harmless as the caricatures of professors and policemen which we see on the stage. But there is a very serious additional reason for Brown's behaviour. An admirable Report has just been published in which it has been thought necessary to emphasise the obvious fact, that an English student who intends to pursue a course in the humanities must, first of all, have a sound and fairly extensive knowledge of his own language and literature. Unless this foundation is well and truly laid, the student's equipment is imperfect, and he is severely handicapped at every turn.

Now, mathematics occupies a precisely similar position with regard to a course in science. To give a full justification of this statement is, of course, impossible here; but an attempt to do so partially will be made by putting an imaginary case. Let us suppose that progress in mathematics had stopped abruptly at the end of the 15th century, a comparatively recent date in the history of the science. The result would be that physics would be almost entirely empirical; there would be no theories at all to account for the motions of the heavenly bodies, for the transformations and indestructibility of energy; no general theories, capable of verification, in physical optics, heat, or electricity. It is extremely unlikely, not to say impossible, that instruments like modern telescopes, microscopes, spectroscopes, or electric and electromagnetic meters of various kinds, could have been invented. Some, at least, of the consequences involved in this can be seen by everyone who considers the matter.

To turn to more banausic or, if the reader prefer it, practical considerations: a single example must suffice. Let us suppose that "practical" engineers had succeeded in constructing a steel steamship, approximating to the modern type. (This in itself is taking a good deal for granted.) The induced variations of its compass would have to be corrected by a blind and tedious process of trial; the skipper would have no Nautical Almanack, no means of determining the exact local time (and consequently his true longitude), no rules to guide him in keeping a great circle course from one given port to another. Similarly biologists and chemists are indebted to physicists and mathematicians for the perfection of their instruments; and such topics as heredity and Mendelism require for their full discussion a good deal of mathematics. Physiology, too, is becoming daily more dependent on physical theory and mathematical formulæ; for instance, a full explanation of the rise of sap in trees must involve a mathematical theory.

Such examples might be multiplied indefinitely. Let us now turn to another aspect of the question. Benjamin Disraeli, who was by no means the charlatan which some people suppose him to have been, is reported to have said that the best way of gauging the commercial prosperity of a country was to find out the condition of the chemical market. We may venture to assert that the intellectual state of a country may be estimated fairly well by its attitude towards mathematics and its progress therein. In this respect England is much inferior to other and smaller nations. For instance, in England many private libraries have been either given to the nation or placed at the disposal of genuine students: very few of these are wholly or mainly mathematical. Contrast with this the Mittag-Leffler endowment, of which an account will be found in NATURE of July 6, 1916, p. 384. The founders expressly emphasised the supreme importance of pure mathematics from a national point of view. Again, no one can dispute the practical efficiency of the American nation; compare their treatment of mathematical professors with ours. An American university teacher may be a specialist devoted to the most abstract and "unpractical" parts of his science; he is left perfectly free to pursue his researches; he is provided with a sufficient staff of assistants; the university library contains an ample store of mathematical books, and all other necessary equipment is supplied. Every seventh year the professor is relieved of his official duties; and the use which he generally makes of his respite may be illustrated by the "History of the Theory of Numbers" (now in course of publication), by Prof. L. E. Dickson. His special subject is the highly abstract one of group-theory: but he spent his sabbatical year in ransacking the libraries of Europe, as well as of the United States, for works on the higher arithmetic. The result is an extraordinary display of laborious and accurate research: the first volume alone contains summaries, almost all of them based upon the author's personal examination, of thousands of papers. The value of the work, when complete, can scarcely be overestimated.

Finally, it is dangerous to neglect mathematics in schemes for a course of general education. From a school teacher's point of view the subject naturally falls into two divisions: (*a*) computation, drawing (including graphs), mensuration, and surveying; and (*b*) the theoretical treatment of the elementary parts of the subject. No attempt should be made at premature specialisation; the needs of the exceptionally gifted pupils may be met by giving them free access (with occasional advice as to choice) to the school library, which should contain books beyond the scope of the school course, and also biographies of mathematicians and works on the history of the subject. The main results to be desired, in the case of an average student, are these, among others: at the end of his course he should have a correct idea of the importance of mathematics and some acquaintance with its aims and methods, whatever his actual acquirements may be. Above all, he should have acquired the habit of intellectual honesty. A mistake in a mathematical exercise cannot be concealed by fudge, or argued about, as in the case of a historical essay or the like.

It is most disheartening to find that an organised attempt is being made to restore the study of Greek and Latin to its old position of prestige; fortunately, a number of eminent classical scholars have taken up a reasonable attitude, so that the danger may not be so great as it seems. Moreover, the report already alluded to should convince everyone that even with regard to the humanities it is not Latin-Greek but English that should be made the principal subject in English schools. The great Greek writers had not been condemned, in their school days, to wearisome lessons in Arabic or Hieroglyphics, although everything now argued in favour of Latin-Greek might have been urged equally well in favour of such preposterous procedure.

G. B. M.

Applications of the Thermionic Valve.[1]

By J. JOSEPH.

THE control of energy at distances of thousands of miles without any other medium than the æther has been made possible by the evolution of the thermionic valve. This remarkable invention can be described briefly as a highly exhausted glass bulb, in which is mounted a tungsten or tantalum filament heated by a battery giving about 6 volts. Electrons are emitted by the heated filament. The filament is surrounded by a grid or gauze cylinder, which is insulated and kept at the negative potential of the filament, while a plate of metal mounted inside the bulb is kept at a high potential of from fifty to several hundred volts by means of a battery or some other source of continuous current. The bulb is highly exhausted, and while the grid is kept at a normal negative potential, steady current passes from the filament to the plate or anode, but as soon as the grid is made slightly positive or negative, the current passing between the filament and anode by virtue of the electronic conductivity is increased or decreased. A valve can be used as a rectifier, as it can be made unilateral in conductivity by suitable adjustments of "grid potential." It can also be regarded as an inertialess relay, it being only necessary for the grid to be affected by the most minute change of potential for the valve to become more or less conductive, when it may be used indirectly to close a circuit and control magnetic or electrical operations.

One of the most important applications of the valve is the amplification of telephone currents in long-distance telephone trunk lines. Here, owing to the length of the cable and to the electrical constants involved, speech becomes greatly attenuated, and thermionic relays or repeaters are introduced about every thirty miles which amplify the speech to its original degree of loudness. In addition, cable of much smaller diameter and weight can be employed, as currents producing almost inaudible sounds can be amplified to any degree of strength. The introduction of these valve relays has effected a saving of thousands of pounds in many of our trunk telephone lines.

Another recent application of the valve is the magnification of the sound of the heart-beat. This is effected by means of a special transmitter, which rests by its own weight over the heart of the patient under examination. The heart creates vibrations in an air-chamber which reproduce exactly the complex action of the blood when passing through the valves of the heart. When connected to a thermionic valve amplifier and a special receiver attached to a large horn, the beat of the heart can be made audible to a number of people in a lecture-room.

The valve has also been used for the simultaneous reproduction of speech with the projection of a film on a screen, both picture and sound vibrations being photographed simultaneously on the same film, thereby ensuring perfect synchronisation. The vibrations of the voice are, by means of microphones, made to agitate a small mirror fitted on the camera adaptor, and a shaft of light passes from the mirror through a narrow slit. As the mirror vibrates, the band of light is reflected at constantly changing angles, and a wave form is produced which corresponds to the vocal sounds of the person speaking, as in the oscillograph. The wave form appears on the side of the film and is reconverted into sounds by means of a selenium cell, which, as is well known, possesses the peculiar property of resisting the passage of electricity in proportion to the intensity of light to which it is subjected. The variations in resistance caused by the passage of the film through the cinematograph are amplified by thermionic valves and made audible through a loud-speaking telephone. There are wide possibilities in this application of the valve.

An important feature of the valve is its great adaptability to the production of sounds of any frequency from one to many millions per second. A valve can be made to generate oscillations if the grid and anode are coupled to coils so as to form a transformer, the circuit of the coils being completed through a battery of 150 volts or more. By connecting a condenser across the anode coil, oscillations are set up, the frequency of which depends on the capacity of the condenser. If a third coil is coupled magnetically to the anode circuit, a note will be emitted corresponding to the frequency of the circuit, and by varying the capacity of the condenser, a wide range of frequencies can be generated for various testing purposes. The note emitted by the receiver is very clear and sharp, and the ease and rapidity with which the frequency can be changed renders the method particularly suitable for aural surgery, where frequencies covering a range of 200 to 3000 are often required. It is well known to aural specialists that certain people have what is known as a silent zone at particular frequencies. For instance, a patient's hearing might be normal for frequencies 200-500 and although he is deaf to frequencies 500-520. The aural appliances at present in use are not suitable for the rapid and accurate production of frequencies of any desired value. With a thermionic generator and a calibration chart, however, the frequency can be varied at will, and if a telephone head-receiver is worn by the patient and connected in series with a variable air condenser and the output or coupling coil, it can be determined readily what frequencies are inaudible to the patient. Further, by varying the capacity of the condenser the sound can be reduced gradually to inaudibility and, by calibration, a scale obtained which will give positions for normal hearing, imperfect hearing, and so on. By this means the effect of treatment can be determined to a very fine degree.

The human ear will not easily respond to frequencies greater than 3000 per second, although frequencies of 18,000 can be detected and instances have been known where 30,000 to 40,000 have also been heard. The frequencies used in wireless telegraphy are governed by the wave-length, and values of 500,000 per second, which correspond to a wave-length of 600 metres, are quite common. In spark telegraphy, the wave trains are

[1] Substance of a contribution to a discussion at the Institution of Electrical Engineers on March 6.

cut up into groups which are rendered audible to the wireless operator by means of a telephone receiver, which gives a click for every wave train, the signal being, of course, first rectified by the valve, so that a succession of musical sounds are heard in the telephone receiver corresponding to the Morse alphabet. The intermediate or high frequencies in each wave train are beyond human audibility, and are therefore not heard. The wave generated by the valve is, however, a continuous one, that is to say, every time the sending key is pressed a group of continuous waves are sent out at a frequency determined by the wave-length. To render them audible in the telephone at the receiving end, a local valve oscillator is used for generating frequencies slightly lower or higher than the received signal and, by heterodyning or superimposing one on the other, a frequency equal to the difference of the two notes is heard in the telephone receiver. This allows of exceedingly fine tuning, for the frequency of the local generator being under the control of the receiving operator, the difference in pitch is adjusted to 1000 cycles, the best value for human reception. It will therefore be seen that frequencies of as low as 1 can readily be detected, although, when the difference becomes very small, there is a tendency for one oscillator to pull the other into step.

Probably, the most interesting application of the thermionic valve is its use in radio-telephony. Here the valve is used to generate continuous waves in a suitable circuit and, by means of a microphone, the voice of the speaker is made to vary the amplitude of this wave at the different audible frequencies which are used in speech formation. These modulations are then conveyed to the aerial, and the telephone diaphragms at the receiving end are correspondingly stimulated and reproduce the speech exactly as transmitted. Numerous other uses have been found for the thermionic valve, among which may be mentioned direction finding, the navigation of aeroplanes in flight, its use as a rectifier for charging batteries, communication between moving trains, and the control of energy at great distances. In the latter direction mention may be made of communication by radio-telephony having been definitely established between England and Australia. Wherever a succession of signals can be received, they can always be amplified and made to operate selective electrical or mechanical relays for controlling power of any magnitude. The future holds a wonderful vision of vast operations at one end of the earth, being controlled by mankind at the other without any other medium than the æther.

Obituary.

Prof. Philippe A. Guye.

By the death of Prof. Philippe Auguste Guye, on March 27, Switzerland loses one of the most eminent of her savants, and the world of science is the poorer by the passing away, in the full maturity of his intellectual powers, of an assiduous and successful cultivator of natural philosophy, distinguished alike for the range and profundity of his knowledge, the force of his genius, his originality, his ingenuity and remarkable experimental skill. Geneva has long been a home of science; some of her citizens are among the most honoured of its votaries, and Guye now assumes his due position on a roll already made illustrious by the names of Saussure, De La Rive, and Marignac.

Philippe A. Guye was born at Saint-Christophe (Vaud) on June 12, 1862. His earliest scientific studies were made at the University of Geneva, where he worked under Graebe, with whom he published papers on diphthalyl and on naphthalene hydrides—a modest enough theme for the 'prentice hand—mainly a repetition of Graebe's observations of ten years previously, which seemed to have been called in question by the subsequent work of Agrestini. After taking his doctorate he repaired to Paris, where he remained some years, working in the laboratory of Friedel. Here he appears to have come under the influence of ideas on spatial chemistry which science owes to Le Bel, and much of his work during the next few years was devoted to their development. In 1892 he was recalled to Geneva to occupy the chair of theoretical and applied chemistry in the university of that city, to which he remained attached for thirty years. During this period Guye, by his energy and personal influence, his organising power, and the catholicity of his scientific aims, made an indelible impression on the academic life and activities of the university. He surrounded himself with a body of earnest and enthusiastic workers, attracted from all parts of the world, to whom he gave freely from a wealth of ideas which ranged over every department of chemical and physical science. It is estimated that upwards of 600 communications emanated from the Geneva laboratory while under his direction, some 200 of which bore his own name alone, many others being joint contributions by himself and his pupils. His own work was characterised by a rigorous sense of accuracy, by caution and a recognition of possible sources of error, amounting almost to intuition, combined with a capacity for generalisation and a *flair* for fruitful hypothesis which seemed, at times, like divination.

Although Guye began his scientific life under the guidance of Graebe, and at a time when the theory of organic chemistry and its technical applications were developing with extraordinary rapidity and success, systematic organic chemistry of the type with which the name of his eminent teacher is associated had few attractions for him, and it is doubtful whether Graebe's teaching and example had any permanent influence on his career. At all events, on his election to the Geneva chair he embarked upon the long series of investigations on problems of physical chemistry on which his fame mainly rests. He was early attracted to the many issues to which the molecular theory of Van der Waals gave rise. He discovered a series of new relations between the physical constants of liquids and their molecular magnitudes, and he greatly extended the conception of molecular association in liquids. He devised new methods of determining the molecular weights of substances in the liquid state and at the critical point. He attacked the study of molecular dissymmetry, and traced the connection between optical activity and homology in liquids, between isomerism of position and rotatory power, and with the aid of his pupils he accumulated a great mass of experimental material which served to extend and substantiate his generalisations.

In 1903 Guye turned his attention to the study of atomic weights, and, in particular, to a critical examination of the experimental basis upon which these magnitudes rest. He thereby followed and perpetuated a tradition with which the fame of the Geneva school of chemistry, as personified by Marignac, will always be connected. Practically the greater number of the 100 contributions to the literature of chemistry which we owe to Guye's pen during the past twenty years are devoted to this subject, upon which he lavished all the powers of his matured intelligence, his experience, ingenuity, and manipulative skill. Thanks to his organising capacity and the ability and enthusiasm of his collaborators, we have been furnished with a series of fiduciary values which are probably among the best determined of physical constants, in which every known source of error has been rigorously scrutinised, and, so far as possible, eliminated. Naturally the trend of modern developments of ideas concerning the essential nature of the elements, and their fundamental relations and possible interdependence, attracted Guye's alert intelligence, and at the Brussels meeting of the International Conference in June last he pointed out their significance in connection with the proposed reorganisation of the work of the International Committee on Atomic Weights, of which he was an enthusiastic advocate, and on which, had he lived, he would certainly have made his influence felt as a member.

It might be supposed from Guye's mental characteristics, and from the nature of his studies, that he would have little sympathy with the technical applications of chemistry. No such surmise could be further from the truth. Although not a professed technologist, he had a considerable knowledge of manufacturing chemistry, and he enjoyed the confidence and esteem of the leaders of chemical industry throughout Switzerland, to whom he was always accessible, and by whom his counsel and advice were highly appreciated. His name will always be associated with the extraordinary development of electrochemical synthesis in Switzerland, to which his lectures and writings largely contributed.

Guye exercised great influence in scientific circles in Geneva, and took a leading part in the organisation of Swiss science. He presided over the Swiss Physical and Natural History Society, was a member of the central Committee of the Helvetic Society of Natural Sciences, and president of the Swiss Chemical Society and of the Council of Swiss Chemistry. In 1903 he established the *Journal de Chimie physique,* in which the greater number of the communications from his laboratory after that year were published, and he was mainly instrumental in placing *Helvetica Chimica Acta*—now the leading chemical journal in Switzerland—upon a sound and permanent foundation.

Guye's merits as a man of science were widely recognised. He was a member of the Scientific Academies of Petrograd, Madrid, and Bucharest, an honorary member of the Chemical Societies of France and England, a corresponding member of the French Institute, and a foreign associate of the Reale Accademia dei Lincei, and he shares with his countryman Marignac the honour of being a Davy medallist of the Royal Society. To the great regret of his many friends in England, the illness which ended in his death prevented him from coming to London to receive the medal in person.

He has another association with the memory of Davy, who died at Geneva, which British chemists will not forget. They are grateful to Guye for his pious care of the tomb which holds the remains of the great chemist.

T. E. Thorpe.

Prof. W. B. Bottomley.

Prof. William B. Bottomley, Emeritus Professor of Botany at King's College, University of London, died at Huddersfield on March 24, aged 58, after a long and trying illness which began in April 1918 with a seizure resulting from thrombosis. During the four succeeding years these seizures returned at intervals until the end.

Prof. Bottomley was born at Apperley Bridge, Leeds, on December 26, 1863, and was educated at the Royal Grammar School, Lancaster, and at King's College, Cambridge. He then studied at Heidelberg, where he received the Ph.D. degree. He was lecturer in biology at St. Mary's Hospital from 1886 to 1891. In the latter year he was appointed professor of biology at the Royal Veterinary College, and at the same time served as assistant in botany to Prof. Oliver at University College, London, and as a Cambridge University Extension lecturer. In 1893 he was appointed to the professorship of botany at King's College, London, which post he held until his resignation in 1920.

In 1905 Prof. Bottomley made a journey round the world in connection with University Extension work. He did a great deal of extra-mural lecturing under various auspices, and was well known as an excellent lecturer before either a scientific or a popular audience.

Prof. Bottomley's chief scientific interests were in connection with plant nutrition and the relation of these problems to agriculture. Towards the end of the nineteenth century he actively concerned himself with various co-operative agricultural movements, such as the Agricultural Banks Association and the English Land Colonisation Society. He was a man of great enthusiasms, and it is much to be regretted that he was unable to complete the important work with which his investigations were concerned. His name will always find a place in the history of plant nutrition, along with those of Boussingault, Lawes, and others. His most important contribution to the subject of plant nutrition was probably the discovery of what he called auximones, or growth-promoting substances, in materials such as peat which had been subjected to the action of nitrifying bacteria. The acidity of the raw peat had first to be neutralised by the action of ammonifying organisms. Experiments at Kew and the Imperial

College of Science, as well as King's College, showed that a striking increase in growth occurred when small amounts of this bacterised peat were added to the soil. This led to the chemical fractionation of such treated peat, the extract being used to test the stimulus to growth of the aquatic plant Lemna, and other plants, in culture solutions. It was found that 368 parts per million added to the culture solution gave in six weeks an increase in weight of 62 times the control plants. Other equally remarkable results were obtained. Various papers on the subject were published in Proc. Roy. Soc. and the *Annals of Botany*.

The method was patented, and in the early years of the war great hopes were entertained that peat deposits in many parts of the world could thus be made of direct service in stimulating food crop production. The controversies to which this commercialising of the process led, together with the loss of a son in the war, no doubt contributed to Prof. Bottomley's subsequent breakdown.

The discovery of auximones will remain a landmark in the long history of plant nutrition. These substances differ from vitamines in that they will withstand a temperature of 150° C., while the latter are largely destroyed by boiling. Moreover, unlike vitamines, auximones apparently have no effect on animals. They are probably derivatives of nucleic acid, and appear to be generated in soils through the activity of soil bacteria. Their presence indicates that these bacteria stand in somewhat the same relation to plants that plants do to animals; for the auximones appear to be bacterial products stimulating plant growth, while the vitamines are plant products which are essential for healthy animal development.

It is greatly to be hoped that these remarkable growth-stimulating substances can be isolated, their composition determined, and the method of their production standardised. They would then be of the utmost value to agriculture.

Prof. Bottomley was a member of the Council of the Royal Botanic Society, Regent's Park, where some of his experiments were carried out. He leaves a widow and two sons at Huddersfield, where the family removed from Hampstead a few months before his death. R. R. G.

DR. H. N. DICKSON, C.B.E.

HENRY NEWTON DICKSON, born in Edinburgh in 1866, studied at the University of Edinburgh and came under the influence of the remarkable activities in experimental physics, meteorology, and oceanography directed by P. G. Tait and G. Chrystal in the University and by A. Buchan and John Murray outside. Like many other Edinburgh students of the later 'eighties of the last century Dickson seized the opportunity of acting as volunteer assistant in the work of the *Challenger* Commission, the Scottish Marine Station, and the Ben Nevis Observatory, and by this practical training in physiography he was fitted to take up the reviving study of geography on a basis of sound physical science. Thus, while his researches dealt exclusively with the special fields of meteorology and oceanography, his appointments were mainly in the teaching or the application of geography in its wider aspects.

In 1891 Dickson was engaged at the Marine Biological Association's laboratory at Plymouth in investigations on the salinity and temperature of the English Channel, and on his removal to Oxford in 1893 he extended this work to the whole surface of the North Atlantic. The water-samples were obtained by the officers of Atlantic liners and analysed by Dickson in the University chemical laboratory. It took several years to bring the methods of collection and discussion to perfection, and finally, with the co-operation of the Meteorological Office, Dickson produced his most important work, "The Circulation of the Surface Waters of the North Atlantic Ocean," which appeared in the Philosophical Transactions for 1901, and included monthly maps of temperature and salinity for the two complete years 1896 and 1897. This won him the Oxford D.Sc. degree in physical geography.

At Oxford Dickson joined the lecturing staff of the School of Geography and was very successful as a teacher. He moved to Reading in 1906, where he acted as professor of geography in the University College until 1920. During the war he gave practically his whole time to work at the Intelligence Division of the Naval Staff, where, amongst other duties, he undertook the preparation of an important series of handbooks descriptive of regions in which military operations were being carried on or where they might occur. For this he was decorated with the C.B.E.

In 1893 Dr. Dickson published a small volume on "Elementary Meteorology," which showed originality in conception and presented the principles of weather study in a very attractive form. This was followed in 1912 by a little book on "Climate and Weather," which was equally happy. He also wrote a book on "Maps and Map Reading." Dickson devoted much time to the study of underground water in the chalk formations near London, and the outbreak of war interrupted a most important investigation on which he was engaged with regard to the evaporation from an exposed water-surface. For this purpose he devised an automatic recording evaporimeter, which, so far as can be ascertained, was never made available for general use.

For many years Dr. Dickson was regular in attending the meetings of the British Association, acting as Secretary and Recorder of Section E, and in 1913 he was President of the Section. He was also a member of Council of the Royal Meteorological Society for many years and was President of the Society for 1911–1912.

His last work was in the Editorial Department of the additional volumes of the "Encyclopædia Britannica" for the 12th edition. Into this, as into all his other work, he threw his whole heart, and probably the most remarkable feature of his character was his indefatigable energy in whatever he undertook. He was married in 1891, and leaves a widow, a son in the Royal Navy, and a daughter. H. R. M.

WE much regret to learn from the Lister Institute that Mr. A. W. Bacot, head of the department of entomology, died at Cairo from typhus on April 12.

Current Topics and Events.

No British statesman of our times is more closely associated with scientific activities, or has done more to promote scientific interests, than Sir Arthur Balfour, upon whom the King conferred the honour of knighthood a few weeks ago and invested him with the insignia of the Order of the Garter. We notice, therefore, with much satisfaction the announcement that the King has been pleased to approve that the dignity of an Earldom of the United Kingdom be conferred upon him. Sir Arthur Balfour was elected a fellow of the Royal Society in 1888 and was president of the British Association at the Cambridge meeting in 1904. He has been Lord Rector of St. Andrews University and of Glasgow University, is Chancellor of Edinburgh University, and in 1919 he succeeded his brother-in-law, the late Lord Rayleigh, as Chancellor of Cambridge University. He is president of the British Academy, and Lord President of the Council, and by the latter office is concerned with the Department of Scientific and Industrial Research, in the work of which he takes active interest. Sir Arthur Balfour possesses a sure faith that no attempt to acquire and improve knowledge is vain, and a reasoned belief in the power of science to help and elevate mankind. He is a peer among philosophers and a trusted leader among statesmen, and the honour which has now been conferred upon him has given particular pleasure to all who work for social, intellectual, and scientific progress.

The retirement is announced of Sir I. Bayley Balfour, Regius Keeper of the Botanic Garden at Edinburgh, Regius Professor of Botany in the University there, and King's Botanist for Scotland. Sir Bayley Balfour succeeded Dickson as Regius Keeper in 1888 and soon initiated that enlightened policy of friendly co-operation between the Commissioners of Works and the Regius Keeper which prevailed throughout his tenure of office. He placed the garden in the unique position it occupies to-day, and made it fruitful of result to botany and horticulture. His strength as Regius Keeper lay in more than one direction, and we may safely place his lovable human qualities and his knowledge of men in the centre of the arch, with his broad-minded, scientific outlook on one side and practical knowledge of horticulture on the other. As an administrator, his knowledge of men and affairs was never exhibited to better purpose than in the happy relations he established with one after the other of a succession of official chiefs who rightly trusted him implicitly. It is scarcely necessary in these columns to refer to Sir Bayley Balfour's position as a scientific botanist, but there is still much for him to do along lines of research he has made peculiarly his own, such, for example, as the differentiation of the great Rhododendron genus, by the characters of the leaf indumentum. As a practical horticulturist, he stands alone in the profundity of his knowledge of plants and their ways. Of late years, taking up the work where Franchet left it in 1900, he has taken the leading part in this country in the enumeration of the discoveries which have been going on for 40 years in the flora of the Western Chinese Alps, and which, in Rhododendron alone, far transcend the epoch-making results of Hooker's exploration of the Eastern Himalaya in the 'fifties. The consideration of the material already to hand, in the discovery of which George Forrest, an old member of the Edinburgh garden staff, has latterly played a major part, has resulted in the publication of a series of invaluable monographic "Notes" on Rhododendron, as well as Nomocharis, Chinese Gentian and Primula, all couched in the lucid style with which many previous publications of Sir Bayley Balfour's have made us familiar.

The King, on the recommendation of the Secretary for Scotland, has approved the appointment of Mr. W. W. Smith to succeed Sir I. Bayley Balfour as Regius professor of botany in the University of Edinburgh, Regius Keeper of the Royal Botanic Garden, Edinburgh, and King's Botanist in Scotland. Mr. Smith has been assistant to the Regius Keeper for several years.

Sir Humphry Rolleston has been elected president of the Royal College of Physicians of London.

Sir F. W. Duke, Under-Secretary of State for India; Sir Berkeley G. A. Moynihan, professor of clinical surgery, University of Leeds; and Sir Ronald Ross, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

The latest news from the Mount Everest expedition reports an uneventful march from Darjeeling through Sikkim and over the Jelepla pass into Tibet. The road then lay along the Chumbi valley to Phari Dzong, to which place stores and grain had been despatched in advance. Gen. Bruce reports that on April 8 the expedition left Phari Dzong for Khimbajong. A message from the Pope wishing the expedition success was received before leaving Darjeeling.

On Tuesday next, April 25, Sir Arthur Keith will begin a course of three lectures at the Royal Institution on "Anthropological Problems of the British Empire." Series II. "Racial Problems of Africa"; on Thursday, April 27, Prof. E. H. Barton will deliver the first of two lectures on (I.) "The Resonance Theory of Audition," (II.) "A Syntonic Hypothesis of Colour Vision"; and on Wednesday, April 26, and Saturday, May 6, Prof. D. H. MacGregor will deliver two lectures on "Industrial Relationships"—(I.) "The Historical Interpretation," (II.) "The Problem of Structure." The Friday evening discourse on April 28 will be delivered by Dr. Arthur Harden on "Vitamin Problems," and on May 5 by Dr. M. Grabham on "Biological Studies in Madeira."

The special arrangements for Easter made by the French Physical Society include an address by Prof.

P. Weiss on the Strasbourg Physics Institute on Wednesday, April 19, and one by Sir E. Rutherford on the artificial disintegration of the elements on the following day, both delivered in the physics theatre of the science faculty of the University of Paris. On Friday a visit is to be paid to the new wireless station at Sainte Assise where the 2-kilowatt Paris-London station will be seen in operation; the continental 100-kilowatt station is just about to begin work, and a transcontinental station of 1500 kilowatts is being constructed. On the Thursday and Friday there will be an exhibition of apparatus at the rooms of the Society. At this exhibition British scientific apparatus makers have a joint exhibit. A number of French instruments not well known in this country will be displayed, as for example the Yvon spectrophotometer, a direct-reading micro-balance, and several wireless telegraphic appliances.

THE second triennial meeting of the Astronomical Union will be held at Rome on May 2–10. The opening address by the president, M. Baillaud, will be delivered at 3 P.M. on May 2, at the Reale Accademia dei Lincei. The following are some of the proposals on the agenda paper: to make simultaneous observations of the variation of solar radiation, including the ultra-violet rays; to endeavour to expedite the completion of the astrographic catalogue; to organise observations of stellar parallax; to open a variable-star bureau at Lyons in collaboration with that at Harvard; to use plates sensitised for the infra-red in order to extend the spectral range and possibly to discover stars hitherto invisible; to organise the re-reduction of older star-catalogues, with a view to proper-motion determinations; to make arrangements for observing the near approach of Eros in 1931; and calendar reform. The Municipality of Rome will receive the delegates on May 4 and they are invited to Florence at the close of the meeting. Visits to Messina, Stromboli, and Etna have also been arranged. Prof. A. Fowler, Royal College of Science, South Kensington, is the General Secretary, and it may be mentioned that Messrs. Cook have arranged on favourable terms for a party leaving London on April 29, and returning on May 13.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1921–22: Telford Medals to Sir Henry Fowler (Derby), Mr. H. N. Gresley (Doncaster), and Dr. H. F. Parshall (London); a Watt Medal to Mr. W. Willox (London); an Indian Premium to Mr. F. G. Royal-Dawson (London); Telford Premiums to Mr. A. W. Rendell (Bournemouth), Mr. W. F. Stanton (Chile), and Mr. A. C. Walsh (Chile). The council has also made the following awards for papers printed without discussion in the Proceedings for the session 1920–21: A George Stephenson Medal to Mr. J. H. Taylor (Buenos Aires); Telford Premiums to Mr. F. H. Hummel (Belfast), Mr. E. J. Finnan (Belfast), and Dr. Herbert Chatley (China); and a Trevithick Premium to Mr. G. E. Lillie (Reigate).

A PAPER by Sir Robert Hadfield, communicated to the Institution of Civil Engineers on April 4, represents the beginning of a very extensive and important research on the corrosion of ferrous metals which forms part of an inquiry, undertaken by the Institution in 1916, into the deterioration of structures exposed to sea action. It is proposed to place a large number of specimens of iron and steel, 1330 in all, in positions in which they will be exposed to the action of sea water under certain definite conditions. The present paper describes the metals selected for these tests, and gives full particulars of their mechanical properties, chemical analysis, and microstructure. In such an elaborate investigation it is obvious that every care should be taken to determine the exact conditions under which a test is made, and with this object in view special efforts have been made to define the properties of the test-pieces as accurately as possible. The materials selected include pure varieties of iron (wrought and Armco irons), mild and medium carbon steels of several kinds, steels containing copper, nickel, or chromium as a means of lessening corrosion, and cast irons. An ingenious system of numbering has been adopted, so that specimens can be identified even in the case of considerable corrosion taking place. The actual tests will necessarily occupy a long time, and will be supplemented by laboratory investigations. The paper concludes with a review of some of the problems and theories of corrosion, and with an estimate of the annual wastage of iron-steel through corrosion. For the whole world this loss is estimated to be 29 million tons, and the cost, after making allowance for protection, to be in the neighbourhood of 700 millions sterling.

IN the March issue of *British Birds* the editor, Mr. H. F. Witherby, gives an account of the progress of the bird-marking scheme during the year 1921. The number of birds "ringed" during the period was 8997, the greatest total for any year since 1914, and the grand total for the thirteen years of the inquiry has reached the remarkable figure of 105,435. The best figures for individual species are those for the black-headed gull and the song-thrush, of each of which more than 11,000 have been marked since the inquiry began. The whole represents a noteworthy achievement, on which Mr. Witherby and his co-operators are greatly to be congratulated, and further important contributions to our knowledge of bird-migration are certain to result from the continuance of the work on this scale. Reference is made by Mr. Witherby to a useful discussion which has recently been going on in the pages of the magazine as to the future development of the inquiry. On the one hand, there are arguments in favour of concentration of effort: larger numbers of certain of the more interesting and "remunerative" species might be marked, and the results would be augmented in value if there were large series of recovery records relating to homogeneous or comparable marking groups. On the other, the opportunities presenting themselves to the majority of cooperators in the inquiry are for promiscuous marking, and these markers might merely be hampered by any attempt at restriction. An account of some of the results of this inquiry was included in the article on "The Migration of British Swallows" in NATURE of March 16.

THE Ministry of Agriculture announces that bees can now be examined for the presence of the Acarine Disease on payment of a fee of 2*s*. for each sample submitted. Live bees only must be sent, and about 30 specimens should be taken from off the combs and packed in a small cage or box provided with ventilation-holes. A piece of muslin should be fastened across the inside for the bees to cling to during transit. A supply of candy sufficient to last for a few days, or a lump of sugar moistened with water, should be wrapped in muslin and fastened firmly to the inside of the box. The latter should be addressed to the Ministry of Agriculture, 4 Whitehall Place, London, S.W.1, and the name of the sender should be written on the reverse side of the label, but crossed through to prevent an error in transit. The remittance should be sent under a separate covering letter with as much information as possible concerning the bees. Payment must be made by postal order or cheque.

ON March 22 at a meeting of the Institution of Aeronautical Engineers a paper was read by Mr. Manning on "Seaplane Design," and on March 31 Mr. H. P. Folland dealt with the subject of aircraft design generally. The programme of future fixtures includes papers by Captain Sayers on "Some Unsettled Problems of Aeroplane Design" and by Major Hume on "The Seaplane's Place in Aviation." Visits have been arranged to the works of the De Haviland Aircraft Company, Simms Motor Units Ltd., the National Physical Laboratory, the South Kensington Museum, and the Croydon Aerodrome. The secretary is Mr. L. Howard Flanders, 60 Chancery Lane, and the president, Col. J. T. C. Moore-Brabazon, M.P.

WE have received from Messrs. Baird and Tatlock, of Cross Street, Hatton Garden, a copy of their new (1922) catalogue of apparatus for use in physiological and other laboratories where similar apparatus is required. The worker will find it a very valuable and an almost complete list of the instruments at present available for teaching and research purposes. In the latter case, it frequently happens that new apparatus has to be designed and fitted up to solve new problems; but the list sent to us will be of much assistance in giving information of what is actually to be obtained for the purpose in view. We note that the collaboration of physiologists has been obtained in the selection of the material to be included and the presence of apparatus for physico-chemical measurements is to be welcomed. The instruments for convenient measurement of electrical conductivity and potential have been somewhat difficult to obtain in recent years in England. The prices on the whole appear to be reasonable.

Our Astronomical Column.

THE SHOWER OF LYRIDS.—These meteors may be expected to return on the night of April 21, and as the moon will be absent this year at the time of the maximum display, they should be well observed. The best hour at which to witness the event will probably be near midnight, for in the morning hours on April 22 the earth is likely to have passed through the denser part of the stream. The shower certainly lasts ten days, but it appears in its most active stage for a short period only. Of late years the meteors of this system have not been visible in striking abundance, and it is an unfortunate circumstance that its period of revolution is unknown. A brilliant exhibition of the meteors may occur in any year, and quite unexpectedly as in 1803 and 1851.

THE POSITION OF NEPTUNE'S EQUATOR.—It has long been known that the plane of the orbit of Neptune's satellite Triton is changing its position. The only probable cause is the oblateness of Neptune, and it follows that the orbit plane makes a considerable angle with the planet's equator. By plotting out the poles of the satellite's orbit at different epochs we get an arc of a small circle, the centre of which is the pole of Neptune's equator. The latest determination of the position of the latter pole is that made by Mr. Arthur Newton (*Pop. Ast.*, March 1922). Making use of 1500 observations of the satellite, made from 1864 to 1908, he gives R.A. 19 h. 17 m., N. Decl. 38°·3 as the northern end of Neptune's axis. The pole of the satellite's orbit describes a circle round this, of radius 14°·7, in 425 years. There is little doubt that Neptune's rotation is retrograde; this has been verified for Uranus by the spectroscope, the period of $10\frac{3}{4}$ h. being found at the same time. In the case of Uranus the equator evidently coincides with the orbit planes, since these are all practically coincident and no change in them has been detected.

DETERMINATION OF STAR MAGNITUDES BY A THERMOPILE.—J. Schilt has devised a new method of determining photographic star-magnitudes, which he describes in Bull. No. 10 of the Astr. Inst. of the Netherlands. The light and heat from a lamp are focussed by a lens on a small circle of the plate, which is somewhat larger than any of the star-images; these images are then moved in succession into the circle of light, and the amount of heat absorbed by the image is measured by the galvanometer of the thermopile. The process is rapid, the equilibrium temperature being attained in three seconds. The probable error, deduced by comparing the measures of two exposures on the same plate, is found to be 0·02 mag., whereas that from the method of diameter of image is 0·11 mag.

The most striking advantage of the new method is that it gets rid of practically all error due to variation in the shape of the image with varying distance from the centre of the plate. It also gets rid of the error that arises in the star diameters in plates taken with a refractor, due to the chromatic aberration which depends on the star's colour. In fact the method appears to give the integrated amount of darkening of the film independently of the size or shape of the image. This is verified by the application of the method to some of the polar plates taken with the 60-inch reflector at Mt. Wilson. The tables show that it gives good results up to a distance of 44 mm. from the centre of the plate, whereas Seares had found that the diameter method needed corrections of about half a magnitude at a distance of only 20 mm. The method would seem to have a large field of usefulness in the photometry of faint stars on reflector plates.

Research Items.

THE ICE AGE AND MAN.—In the January and April issues of *Man*, Messrs. H. J. E. Peake and J. Reid Moir have published schemes correlating the palæolithic types of culture with the geological strata. The conclusions proposed by both writers agree fairly, except that in Mr. Reid Moir's scheme the position of the Alpine glaciations has been moved up one stage. On this Mr. Peake remarks: "According to Mr. Reid Moir the Mousterian straddles the Riss, while Obermaier has argued with much force that it straddles the Würm, and the Magdalenian immediately precedes the Würm, while Penek and Schmidt have shown that this phase extended into the Bühl. This divergence seems to require some explanation."

RUSH AND STRAW CROSSES.—Rude bundles of straw or rushes, in the form of crosses, are often found hung over the doors in many parts of Ireland on St. Brigid's Day, the February festival marking the end of winter and the beginning of spring. Miss E. Andrews, who discusses the question in the April issue of *Man*, with a good illustration, suggests their connection in form with the Swastika, and infers that we have in them a very ancient symbol used in pagan times to represent the sun emerging from the darkness of winter. This ingenious explanation is supported by a certain amount of evidence, and it deserves consideration.

ANIMALS ON THE ROOF.—In the March number of *Folk-lore*, Prof. H. J. Rose of University College, Aberystwyth, attempts to explain a passage in Petronius where Trimalchio speaks of Asinus in Tegulis—the portent of an ass appearing on the tiles. He brings together a number of examples showing that in the lower culture the appearance of an animal or a bird on the roof is regarded as portentous. This leads to the consideration of the roof in connection with beliefs regarding the house. He suggests that in the case of Trimalchio's ass the animal may have been conceived as an evil spirit or a new and particularly disagreeable form of ghost. The uncanny effect of fire-light on the rude thatching and the smoke-wreaths, the strange scratchings and patterings of small nocturnal animals running over the top of the hut, nightmares in which the roof threatens to fall and crush the sleeper, real injuries from the collapse of the flimsy structure, the intrusion of beasts of prey, bats, moths, and small birds fluttering about inside—all these and many other factors may well have united to make up the sum of this curious chapter of folk-belief.

CYTOPLASMIC INCLUSIONS OF THE GERM-CELLS.—The discovery of the chromosomes and their behaviour both in ordinary cell-division and in the maturation of the germ-cells opened up a new era in the study of the mechanism of heredity, and it is now widely believed that the chromosomes are the bearers of "factors" or "genes" that are responsible for the transmission of heritable peculiarities. In recent years, however, a good deal of attention has been paid to certain structures, the "mitochondria" and "Golgi apparatus," that occur in the cytoplasm, outside the nucleus, and it has been suggested that the mitochondria, at any rate, may constitute the protoplasmic basis of heredity. In the current number of the *Quarterly Journal of Microscopical Science* (vol. 66, part 1) Prof. J. Brontë Gatenby concludes his notable series of memoirs on "The Cytoplasmic Inclusions of the Germ-cells," and expresses the opinion that "As direct bearers of any important or precise factors of heredity, the Golgi body and mitochondria appear to be ruled out by their inexact and variable behaviour in the germ-cell cycle. The chromosomes, and the chromosomes alone, fulfil the necessary conditions."

ENTERONEPHRIC EXCRETORY ORGANS IN EARTHWORMS.—A few years ago a remarkable "enteronephric" system of excretory organs in Pheretima was described by Dr. K. N. Bahl, consisting of modified nephridia which open by a system of ducts into the alimentary canal, instead of opening on the surface of the body as in the usual (integumentary) type. The system consists of septal and pharyngeal nephridia. It was a matter of considerable interest to determine whether these modified nephridia are formed from the epiblast of the embryo, like ordinary nephridia, or whether they develop in some other way. Dr. Bahl has now investigated this problem and gives in the *Quarterly Journal of Microscopical Science*, vol. 66, Part 1, a detailed embryological account of the organs in question, as well as of the integumentary nephridia of the same worm. He finds that all three types can be traced back to the original epiblastic row of nephridial cells. The connection of the enteronephric system with the alimentary canal is evidently a secondary feature that has arisen comparatively late in phylogeny.

THE EFFECT OF TEMPERATURE ON THE ABSORPTION SPECTRA OF GLASSES.—The observations of Houstoun on the absorption spectra of eight or nine kinds of coloured glass showed in 1906 that, while in most cases an increase of temperature from 15° C. to about 330° C. produced in the visible spectrum an increase in the absorption on the longer and a decrease on the shorter wave length side of an absorption band, this was not invariably the case. Nor was the absorption in all cases decreased by increase of temperature. Gibson in 1916 investigated five glasses at −180° C. and 430° C. in the visible part of the spectrum, and found in some cases, as for instance that of a red glass, that the absorption for a particular wave length increased at the higher temperature to fifty times its value at the lower. In a Ph.D. thesis of the University of Pennsylvania recently issued, Mr. G. Rosengarten describes his measurements of the absorption of a number of coloured glasses in the infra-red between wave lengths 1 and 5×10^{-4} cm. His source was a tungsten lamp, his spectrometer prism of rock salt, and the issuing radiation was measured by a thermo-pile. Up to 500° C. he finds the changes in absorption seldom exceed the instrumental error of 8 per cent.

COLOUR SENSITIVE PHOTOGRAPHIC PLATES.—We have received from the Bureau of Standards, Washington, a copy of a communication entitled "Studies in Colour Sensitive Photographic Plates and Methods of Sensitising by Bathing," by Francis M. Walters, Jr., and Raymond Davis. The authors describe their methods of investigation, and deal with pinacyanol in considerable detail. They have also investigated the use of dicyanin, erythrosin, pinaverdol, pinachrome, orthochrome T, and homocol, as well as the hypersensitising of commercial panchromatic plates. They find that the various dyes require different methods for their most successful application. The previous washing of the plate to be treated is sometimes of great importance, and the effects of alcohol and of ammonia need, perhaps, more attention than they have hitherto received. The paper is well illustrated. It is ready for distribution and any one interested may obtain a copy from the Bureau until the free stock is exhausted.

A Unique Long-period Variable Star.

By Major W. J. S. Lockyer.

SINCE the year 1811 the star designated R. Aquarii (position for 1900 Right Ascension 23^h $38{\cdot}6^m$, Declination $-15°$ $50'$) has been known as a variable star. It goes through a complete cycle of variability in 385·5 days, attaining a maximum brightness of 6·2 and a minimum of 11·0.

This star, like about 85 per cent. of all long-period variables, has a spectrum of the class Md, *i.e.* a spectrum showing bright hydrogen lines and numerous absorption flutings of titanium-oxide on a continuous spectrum, and indicative of comparatively low temperature.

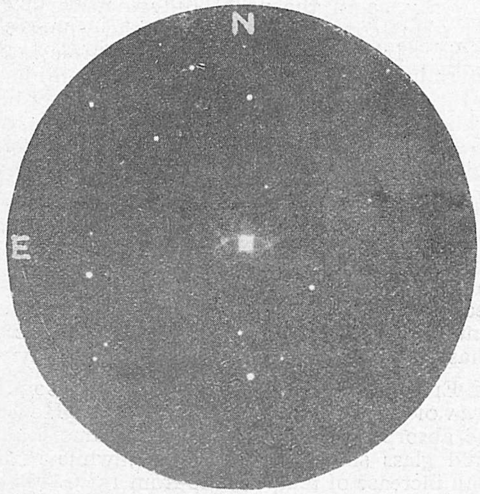

Fig. 1.—Nebulosity around R. Aquarii.
Photographed by C. O. Lampland, Lowell Observatory.

On October 16, 1919, Mr. Paul W. Merrill, using the 100-inch reflecting telescope of the Mount Wilson Observatory, discovered that several other bright lines, characteristic of gaseous nebulæ, were present. This made the spectrum unique, because while there is considerable evidence to connect hot stars, such as Class O or Wolf-Rayet Stars, with gaseous nebulæ, there was no instance, prior to this, in which a comparatively cool star is associated with the nebulæ.

A further interesting observation that has been made is that while the nebular lines remain almost constant in intensity throughout the light changes of the star, the other lines representing the Md spectrum vary through a large range. This suggests that the star and nebula are independent of one another: other observations on the other hand tend to show a close connection between the two.

The most recent discovery relating to this star is of extreme importance, for it is now known that the star is in the centre of a mass of nebulous matter.

The photograph showing this was taken by Mr. C. O. Lampland with the 40-inch reflecting telescope of the Lowell Observatory. This nebular image he describes as an oval-shaped, elongated configuration composed of arcs of well-defined nebular filaments and the star is centrally and symmetrically placed. The position-angle of the longer axis of the formation is about 90° and the greatest extent of the faint structure in this direction is a little more than two minutes of arc. Mr. Lampland has forwarded a positive photograph on film from which the accompanying illustration (enlarged twice) has been made. On his photograph 1 mm. represented 24·5 seconds of arc (approx.).

The general form of the nebulosity here displayed is very similar to that of the nebula N.G.C. 5921. This latter is reproduced on Plate I. in vol. xiii. of the "Publications of the Lick Observatory," and is given there as an example of what Mr. H. D. Curtis calls a ϕ-Type Spiral Nebula.

The actual presence of this nebulosity is of great value in accounting for the unique character of the star's spectrum. Attention must also be directed to the importance of long-exposed photographs with powerful reflectors for the purpose of searching for nebulosities whenever nebular lines appear in a spectrum. It will be remembered how such lines, appearing in the spectra of novæ in the later stages of their career, led to the discovery of the presence of nebular matter surrounding the star.

Marine Invertebrates.

FURTHER reports on material collected by the British and Australian Antarctic Expeditions have been received. The Chætognatha of the Australian Expedition have been described by Prof. T. H. Johnston and Mr. B. B. Taylor, systematic accounts of the Crustacea of the British (*Terra Nova*) Expedition are given by Mr. R. W. Barney on the Ostracoda, and on the Tanaidacea and Isopoda by Dr. W. M. Tattersall. Dr. H. M. Woodcock and Miss Olive Lodge describe the collection of parasitic protozoa, which consists of only three species—a new species of the flagellate genus Cryptobia, a new species of Gregarine (Selenidium), and a ciliate. This ciliate, for which a new genus (Hæmatophagus) is created in the family Stentoridæ, is parasitic on the baleen plates of the humpback whale, and feeds exclusively on the whale's red-blood corpuscles. It reaches a length of 1-1·5 mm., and secretes a delicate transparent tube, up and down which it moves; when feeding the oral end of the ciliate may project from the tube. The red-blood corpuscles are directed into the mouth by the adoral zone of strong cilia fused into membranellæ, pass into the protoplasm, and become enclosed in food-vacuoles. The larger vacuoles may contain numerous corpuscles which become compressed, and, owing to the dissolution of the envelope of the corpuscles, the hæmoglobin-containing substance of all the red cells in the vacuole merges into one homogeneous mass. As digestion proceeds the vacuoles pass gradually backwards, and pigment—agreeing in appearance with melanin—is formed on the outside of the vacuole. Hæmatophagus is unique among ciliates in producing melanin as a result of the digestion of hæmoglobin. This pigment tends to accumulate in the hinder half of the body, and the authors find evidence that when the organism is full-grown the pigment is got rid of by casting off that portion of the body prior to the commencement of the resting, multiplicative phase. How the blood of the whale becomes available to the ciliate has not been established.

Mr. C. H. Edmondson gives (Occasional Papers, Museum of Polynesian Ethnology and Natural History, Honolulu, 1920) a short account of the edible mollusca of the Oregon coast. These are all bivalves; some, belonging to the genera Siliqua and Mya, are known locally as "clams" of various kinds, and there also occur two species of Mytilus, a pecten, a cockle, and an oyster. The Indians made extensive use of these molluscs before the advent of the white man on this coast, as is shown by the great heaps of shells still remaining. *Mya arenaria*, which was transported from the Atlantic coast many years ago, probably with oyster-spat, has become well-established in many localities on the Pacific coast, where it inhabits the mudflats of bays and has advanced up some estuaries, always remaining, however, within the influence of salt water. The author records that in January, 1918, excessive rainfall caused exceedingly high water in one of these estuaries, the Mya being washed with comparatively fresh water for four weeks, and at the end of the period a dense layer of fine sand, up to 2 in. in depth, covered the clam bed. A high percentage of the younger and weaker individuals was found to be dead, probably smothered by the fine silt. Mya is found to withstand transportation to inland markets if kept at a low temperature, and will remain in good condition for a week after having been taken out of the water, but the other clams cannot be sent successfully any distance in marketable condition. Certain of them are canned at the coast. Observations are given on the spawning periods and growth of the bivalves.

The attention of students of recent Crinoids may be directed to a paper by Dr. Austin H. Clark on "Sea-lilies and Feather-stars" (Smithsonian Misc. Coll., vol. 72, No. 7, 1921). The account, while devoted chiefly to external and skeletal features, includes short notes on regeneration, asymmetry, distribution, food, locomotion, etc.

Water-power Resources of India.[1]

THE Triennial Report (1919–1921) of the Hydro-Electrical Survey of India, which has just been received, is of the character of a comprehensive volume, embodying all the essential information contained in the preliminary and second Reports, which have already been noticed in NATURE. In addition, it contains later information derived from the investigation of certain sites selected for their potential value as sources of water-power supply. In the result, the opinion is formed "as a rough preliminary forecast" that the probable water of India for maximum development is some 12,680,000 kilowatts, equivalent to $21\frac{1}{2}$ million water horse power, of which only $1\frac{1}{4}$ per cent. so far is developed or in course of development. The estimate is, of course, to be received with caution, as it is largely "speculative and based on the minimum of reliable information." The water power actually developed at the present time amounts to 138,780 kw., (continuous), capable of being expanded to 213,150 kw., in accordance with the ultimate capacity of the sites exploited. The following is a detailed summary of the probable *minimum* continuous water power:—

	Kw.
Assam	414,000
Baroda	4,000
Bengal	669,850
Bihar and Orissa	62,550
Bombay	644,310
Burma	951,570
Central India	680
Central Provinces and Berar	137,560
Cochin	4,000
Coorg	1,500
Gwalior	43,300
Carry forward	2,933,320
Brought forward	2,933,320
Jammu and Kashmir	305,330
Madras	92,310
Mysore	48,500
North-West Frontier	1,000,000
Patiala	290
Punjab and Canals	793,150
Rajputana	160
Sikkim	5,000
Travancore	450
United Provinces and Canals	403,370
	5,581,880

The Survey is being made under the supervision of Mr. J. W. Meares, who was appointed Chief Engineer in succession to Mr. F. E. Bull. It is noteworthy that the same reluctance to finance hydrographical surveys exists in India as in other parts of the Empire. Mr. Meares is much concerned as to the outlook. As a consequence of the "Reforms" made by the Government of India, it was decided in October, 1920, that all outlay on water storage and water power would be a Provincial charge and that the necessary provision for hydro-electric surveys should therefore be made in the Provisional Estimates from and after the year 1921–22. When the Estimates came up for approval before the various legislative councils, in many instances reductions were moved, and as the matter now stands "the Survey is in danger of falling between the upper and the nether millstone, as the Government of India is no longer able to provide funds for a continuance of the work."

A considerable quantity of useful data is incorporated in the volume, including seven plates and maps, 23 diagrams, and 51 tables. Much detailed information is set out for the guidance and direction of those engaged in the Survey, of whose cordial cooperation Mr. Meares speaks very highly.

[1] Hydro-Electric Survey of India. Volume III. Triennial Report with a Preliminary Forecast of the Water Power Resources of India, 1919 to 1921. By J. W. Meares. Pp. ix+199. (Calcutta: Government Printing Office, 1921). 4 rupees.

University Pensions.

THE Sixteenth Annual Report of the Carnegie Foundation for the Advancement of Teaching provides some interesting reading, especially regarding pension systems. The claim is made that in the Reports of the Foundation will be found "the most complete information concerning pensions and pension systems in existence." The remarks on the University Teachers' pensions in England and Wales deserve notice. Reference is made to the movement of the Association of University Teachers to secure the extension of the School Teachers (Superannuation) Act of 1918 to University teachers, or failing this to obtain benefits at least equivalent to those offered by the Act. As in previous years, the Report shows a strong bias against any non-contributory scheme. It is very easy to understand why this should be so. The Teachers' Insurance and Annuity Association of America could not have come into existence on any other than a contributory basis. On its own showing the Foundation was unable to finance a scheme such as is growing up in America. But no attempt is made to demonstrate how such a contributory scheme can be "sounder" than a non-contributory scheme backed by the government of the country. It would be difficult to do so in face of the existence of the British Civil Service, and the report wisely refrains from the attempt.

In regard to the "problem of transfer" the report is greatly at fault. It is a pity the writer of it did not seek more accurate sources of information or at least endeavour to understand the facts of the case. At the present moment, and for the future unless a change is made, a teacher who "transfers" to a university sacrifices superannuation benefits in whole or in part. This is acting adversely upon the recruiting of university staffs, and will continue so to act unless some attempt is made to obviate this loss. We can assure the writer that the question of transfer from the lower to the higher branches of the profession in this country is a really serious one, and one which is felt especially in the departments of science and technology, as well as in those for the training of teachers. For example, some schools of the University of London come under the Act and others under the Federated Superannuation System, two totally different schemes, and in consequence transfers from one college to another in one and the same university are difficult if not impossible.

It may interest American university teachers to know that the British Government has made a grant of half-a-million towards retrospective benefits ("accrued liabilities") for the senior members of the teaching staffs in the universities—a sum which, by the way, is quite inadequate for the purpose—but for some extraordinary reason has made no provision for retrospective benefits in regard to teaching service in institutions and schools outside the universities. Is there any better way of making watertight compartments of the various branches of the teaching profession ?

University and Educational Intelligence.

CAMBRIDGE.—Close on the publication of the report of the Royal Commission commending the women's colleges to private benefactors comes the welcome announcement of a bequest to Girton College of 20,000*l*. This money, left by Rosalind, Countess of Carlisle, is earmarked for scholarships of 80*l*. per annum for girl students unable to pay for themselves.

LONDON.—The following doctorates have been conferred :—Ph.D. (Science) on Mr. A. C. Chibnall, for a thesis entitled "The Distribution of Nitrogen in the Leaves of the Runner Bean"; Mr. T. J. Drakeley, for a thesis entitled "The Ultimate Composition of British Coal"; Mr. H. S. Hatfield, for a thesis entitled "On a New Method for the Separation of Mechanical Mixtures of Powdered Substances"; Mr. G. H. G. Plymen, for a thesis entitled "The Geology of Jersey and Alderney"; Thirza Redman, for a thesis entitled "Observations on (Experimental) Intestinal Tuberculosis"; Barbara Russel-Wells, for a thesis entitled "The Constitution of the Cell Wall in Plants, more particularly that of the Red Seaweeds"; and Mr. T. Thomas, for a thesis entitled "The Effect of Stress on the Thermo-Electric Properties of Metal Wires with and without a Magnetic Field."

At University College, Gower Street, W.C., a course of six lectures on the Early History of the Land Flora will be given by Dr. D. H. Scott at 5.15 P.M., on Wednesdays April 26 and May 3, 10, 17, 24, and 31. The lectures will be illustrated by lantern slides.

At King's College, Strand, a course of four lectures on Biological Aspects of Oceanography will be given by Dr. Johan Hjort (of the University of Christiania) at 5.30 P.M., on April 28, May 1, 2, and 5. The lectures will be delivered in English.

At Bedford College for Women, Regent's Park, a course of three lectures on "L'Intelligence et la Volonté" will be given by Prof. E. Claparède (professor of psychology in the University of Geneva) at 5.15 on April 28, May 1 and 2. The lectures will be delivered in French. Admission to all these lectures is free without ticket.

Two Munitions Committee Fellowships in research in engineering are offered by the University of Liverpool. The fellowships are tenable in the first place for one year, value 250*l*. each, but may be renewed for a second year when their value will be 350*l*. each. Forms of application and all particulars may be obtained from the Registrar of the University. Applications for the fellowships must be received before June 1.

SOME interesting summaries are provided in *Science* of March 17 showing the number of doctorates in science conferred by American universities in the year 1920–1921, and their distribution according to subject. In all, 332 doctorates in science were conferred by 32 institutions, an increase of nine on the corrected figures for the previous year; with one exception, they were distributed over the same universities. In spite of the increase, the number still falls far short of the maximum, 372, recorded for 1917. As has been the case for several years past, the biggest number, 42, was awarded by the University of Chicago, though Cornell, Columbia, Yale, Harvard, California, and Johns Hopkins Universities all conferred more than 20 doctorates each. Chemistry has, since 1912, claimed a great many more doctorates than any other subject, and in 1921 it seems to have been more popular than ever; no less than 134 doctorates of the total of 332 were given for this subject while the next highest figure is 36, the number of doctorates awarded for zoology. Botany, physics, and psychology were each of them the subjects of the theses of 25 to 30 doctorates.

ON Monday, April 24, Dr. Malinowski, the well-known Polish sociologist, will deliver at the London School of Economics the first of a course of eighteen lectures on "The Sociology and Economics of Some Island Communities." This course of lectures embodies the results of an investigation of four years' duration in the course of which Dr. Malinowski made an intensive study of the culture of the Papuo-Melanesian communities on the coastal mainland and on the archipelago around the eastern end of New Guinea and more particularly of those of the Trobriand Islands. The complex economic system, of which Dr. Malinowski has already given some account in a previous course, will be analysed, and the remarkable manner in which their intricate economic system permeates their whole life will be described. In this field of investigation, Dr. Malinowski's results were not only unexpected, but they threw an entirely new light upon certain elements in primitive life. In like manner his investigations have revealed a definite, though rudimentary, legal machinery for the preservation of law and order. The regulation of sex life by taboos has given rise to a mythical cycle and a whole system of love-magic; while sorcery, which plays a large part in the life of the native, is based upon a complex system of auto-suggestion and counter-suggestion. The most significant feature in the material which Dr. Malinowski has collected, is the extraordinary complexity and inter-relation of the elements of native life. On more than one occasion reference has been made to difficulties arising out of this complexity when native custom is modified under European authority. Dr. Malinowski's results, from this point of view, are a strong argument in favour of the institution of a central organisation at which such data as these may be made available for the use of administrators.

Calendar of Industrial Pioneers.

April 20, 1821. Franz Karl Achard died.—Descended from a French protestant family, Achard was born in Berlin, worked at chemistry with Marggraf and became director of the physical department of the Berlin Academy of Sciences. He was a pioneer in the production of sugar from beetroot and in 1801 erected a sugar factory.

April 21, 1819. Oliver Evans died.—Born in Newport, Delaware, in 1755, Evans became a practical miller. He was the author of numerous improvements in milling, and his system was adopted both in America and Europe. He also experimented with high-pressure steam; in 1803 he began building steam engines, and the same year constructed a self-propelling dredging machine.

April 21, 1889. Robert Stirling Newall died.—The inventor in 1840 of iron wire ropes, Newall established works at Gateshead and became famous as a maker of submarine telegraph cables. The first successful cable between Dover and Calais was made by him in 1851, and he constructed half of the first Atlantic cable. He was also known as an astronomer, and presented one of his large telescopes to the University of Cambridge.

April 22, 1833. Richard Trevithick died.—One of the greatest engineers and the most fertile inventors of his day, Trevithick, like Evans, turned his attention to the use of high-pressure steam, constructed double-acting high-pressure engines, and between 1797 and 1808 made important experiments with locomotives. The son of a manager of a mine, Trevithick became chief engineer of some of the mines in Cornwall. In 1813 he erected some of his engines in Peru, where he resided about ten years.

April 22, 1864. Joseph Gilbert Totten died.—Trained as a military engineer at the West Point Academy, Totten rose to be colonel of the Corps of Engineers of the United States, and became known for his researches on the strength of materials and allied subjects, his work on the lighthouse board, and his investigation of New York harbour.

April 23, 1897. Adam Hilger died.—The founder of a firm of scientific instrument makers, Hilger was a native of Darmstadt. After being trained as a mechanical engineer he worked under Ertel in Munich and under Lerebours in Paris and about 1870 came to England. A few years later he set up in business for himself at Islington, becoming well known as a constructor of instruments for celestial spectroscopy.

April 25, 1840. Sir Robert Seppings died.—Master Shipwright at Chatham Dockyard, and then from 1813 to 1832 Surveyor of the Navy, Seppings introduced improved methods of docking and undocking ships, and was the inventor of the system of diagonally bracing and trussing the frame timbers of ships, an innovation of the first importance. He gave an account of his improvements to the Royal Society and was awarded the Copley medal.

April 26, 1893. Edward Alfred Cowper died.—An apprentice of John Braithwaite, Cowper afterwards worked with Fox and Henderson, and was employed on the buildings for the Great Exhibition of 1851. He then became a consulting engineer and was known for his work in connection with the development of the compound steam engine, his invention of the regenerative hot blast stove, and the introduction in 1868 of the modern bicycle wheel with wire-spoke suspension. In 1880 he was elected President of the Institution of Mechanical Engineers.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, April 6.—Sir Charles Sherrington, president, in the chair.—F. E. **Smith**: On an electromagnetic method for the measurement of the horizontal intensity of the earth's magnetic field. A Helmholtz-Gaugain arrangement of coils consisting of two interwoven helices of bare copper wire wound in spiral grooves in a marble cylinder are mounted on each side of the centre. Each coil is of 30 cm. radius, of six turns, and of $1\frac{2}{3}$ mm. pitch. The cylinder is mounted on a non-magnetic base, and can be rotated about a vertical axis. The magnet at the centre is 1 cm. long and about 6 sq. mm. in cross-section; it is supported on a V of aluminium foil by a fine quartz fibre, to which is attached a reflecting mirror and a damping vane. The magnet is easily removed from its support, and a copper wire of equal weight substituted. The axial magnetic field due to the current in the coils is made slightly greater than "H," and its component in the magnetic meridian opposes H. By adjustment of the angle α between the axis of the cylinder and the direction of magnetic north, the indicator magnet is caused to set at right angles to the meridian. When torsion is eliminated, $H = Fi \cos \alpha$, where F is constant of coil system and i is current. A determination of H occupies less than 4 minutes. The probable error, including that due to uncertainty of the value of the current, measured by a current balance, is about ± 4 in 100,000.—G. I. **Taylor**: Stability of a viscous liquid contained between two rotating cylinders. Steady motion of viscous liquid between two concentric rotating cylinders is unstable for symmetrical disturbances, provided the velocity of the system is greater than a certain value, and the ratio of angular velocities of the cylinders is less than the reciprocal of the square of the ratio of their radii, or is negative. The type of instability is periodic along the length of the cylinders, consisting of vortices enclosed in partitions rectangular in section, and they rotate alternately in opposite directions. When the cylinders rotate in the same direction each vortex extends across the space between the cylinders. The length occupied by each vortex is equal to the thickness of fluid between them. When the cylinders rotate in opposite directions, two systems of vortices rotating as though geared together appear. Some criteria for stability in approximate form suitable for numerical computation have been obtained.—T. H. **Havelock**: Dispersion formulæ and the polarisation of scattered light; with application to hydrogen. Simple types of dispersion formulæ are considered when the medium consists of anisotropic molecules distributed at random and having an axis of symmetry. A formula for the corresponding ratio of the intensities of the two polarised components of light scattered at right angles, when the primary light is unpolarised, is given. The case of hydrogen is examined numerically and the ratio of the intensities agrees substantially with Lord Rayleigh's experimental value.—G. R. **Goldsbrough**: The cause of Encke's division in Saturn's ring. A satellite will, from its inclined path alone, produce one new division in the ring system. If the satellite be Mimas, a narrow division closely corresponding to Encke's division is produced. Similarly, Enceladus should produce a division in Ring B, but it would be almost unobservable.—C. **Spearman**: Correlation between arrays in a table of correlations. Correlations between arrays are expressed as functions of the independent variable elements entering into the main variables. When only one element is common to any different variables, then the correlation between every two parallel arrays amounts to plus or minus unity. The converse is also true. The correlational coefficients considered are derived from product moments and the proofs do not assume any "normal" frequency distributions.—W. L. **Balls**: Apparatus for determining the standard deviation mechanically. The apparatus is related to the "Harp" Harmonic Analyser, similarly utilising separately loaded strings to deflect a yoke upon which they all converge. The design of the yoke has been modified to make the readings quantitative, and each string is loaded in proportion to the square of its deviation from the zero position. A template representing the frequency curve under examination is inserted behind the loaded strings, and the movement of an optical lever gives the "sum of the squares of the deviations." The reading is then transferred to a monograph to complete the calculation. The values obtained are correct to within 5 per cent.

Association of Economic Biologists, March 31.—Prof. E. B. Poulton, president, in the chair.—W. Lawrence **Balls**: The advantages and disadvantages of team work in economic biology. An attempt to enunciate certain principles governing the increasing development of team work between different scientific workers and sciences, particularly on the industrial and economic side. Minor principles: (1) the team leader must administrate research, and not merely administrate; (2) the "scientific management" of scientific research must be considered; (3) every new problem needs a new method. Of major principles, apart from the self-evident essential of sincerity, two are enunciated: (1) The specialist in an applied science must be a "jack-of-all-trades"; (2) the scientific worker's code of "individualism in effort and credit; communism in results" must not be contravened.—F. **Kidd**: Problems of fruit storage. The uses of fruit storage in commerce were described and an outline given of the amounts of fruit imported into this country as compared with what is grown ourselves. Apples, more particularly, were dealt with as one of the most important crops and our backward position in relation to other countries with regard to apple storage pointed out. An account was given of experiments carried out to test the efficacy of gas storage, a cheaper method than cold storage, the possibility of which was first suggested by purely scientific work carried out by the author on the effect of carbon dioxide and oxygen upon germination and growth. Finally, the author dealt with a series of recent experiments upon the respiration of apples during their storage life after gathering. At each of three temperatures tested, 2·5° C., 10° C., and 22·5° C., the rate of respiration changes with age in similar manner, first rising, then falling. The age changes in the respiration curves are, however, not related to the amount of respiration. Apparently, while the respiration rate has a temperature relation of 1 : 2·5 : 8, the age factor has a temperature relation of the order of 1 : 4 : 30, and consequently at analogous points on the age respiration curves more carbon dioxide has been produced at 2·5° C. than at 10° C. or 22·5° C.

Zoological Society, April 4.—Prof. E. W. MacBride, vice-president, in the chair.—R. H. **Burne**: The recessus orbitalis in flat fishes.—L. T. **Hogben**: The influence of pituitary gland in inducing metamorphosis of the Axolotl.—J. T. **Cunningham**: Mendelian experiments on fowls. III. Production of dominant pile colour.—M. **Khalil**: A revision of the nematode parasites of elephants, with a description of four new species.

Linnean Society, April 6.—Mr. H. W. Monckton, vice-president, in the chair.—A. B. **Rendle**: A seedling of the red horse-chestnut (*Æsculus rubicunda*) in which a new terminal bud had been developed to replace the original shoot springing from the seed. The original main shoot, broken some distance below the plumule, was covered after a few days by a new growth which developed into a new terminal bud. The new bud resembled a normal terminal bud the outer leaves of which are imperfect.—L. A. **Borradaile**: The mouth-parts of the shore crab, *Carcinus mænas*. Each of the paired appendages plays a distinct part in manipulating the food. The circulation of the water in the gill-chamber follows a definite course dictated by the arrangement of the organs. The maxillipeds of the third pair of appendages function in feeding, as an operculum, and as cleaning organs.—C. **Turner**: The life-history of *Staurastrum Dickiei*, var. *parallelum* (Nordst.). The contents of the spores of this desmid were, at first, of an oily character. During later stages four nuclei were visible; this apparently indicates that conjugation resulted in a diploid nucleus, and that a reduction division occurred inside the spore before the discharge of its contents. Germination results in the formation of four, three, two, or one desmid only, usually accompanied by an atrophied nucleus in the surrounding protoplasm when the smaller numbers are formed. Conjugation is usually of the normal type, and the zygospores are produced between the two desmids; a conjugation tube was seen in one instance only. The conjugating desmids were asymmetrically placed and the protoplasmic contents indicate a slight differentiation of the sexes. The conjugation of a four-rayed with a three-rayed form is not infrequent, and a four-rayed form may occasionally be seen associated with the three-rayed embryonic desmids in the protoplasm discharged from the same spore, when germination takes place. The vegetative division often occurs by the development of a single circular bulging cell between the two semicells. The contents may divide, or an hour-glass constriction may cause the ultimate formation of two desmids.

PARIS.

Academy of Sciences, March 13.—M. Emile Bertin in the chair.—M. **Hamy**: A property of photographic emulsions and the registration of stars during total eclipses of the Sun in view of the verification of the Einstein effect. It has been found that a short exposure of a photographic plate to light of very feeble intensity, short of producing fogging, increases the sensibility of the plate, so that a plate which just shows a fifth magnitude star before this treatment shows a seventh magnitude star after the preliminary exposure, the time being the same in both cases. The bearing of this on the photography of stars round the Sun during a total eclipse is discussed.—C. **Guichard**: Networks which are harmonic to one C.L. congruence and conjugate to another C.L. congruence.—J. **Andrade**: The mechanical problems of regulating springs in chronometers.—C. **Nicolle** and E. **Conseil**: Preventive vaccination by the digestive tract in man. Experiments on voluntary subjects (Europeans) showed that the dead cultures of organisms secured immunisation in man against Mediterranean fever and dysentery. In the latter, owing to the danger of subcutaneous inoculation, the use of a digestive vaccine offers great advantages.—M. **Lecat**: Abnormal caylians and bicaylians.—K. **Popoff**: The general equation of the elliptic type.—E. **Cartan**: Generalised space and the theory of relativity.—E. **Bompiani**: The geometry of curved spaces and the energy tensor of

Einstein.—M. **Frontad**: Logoids of slipping of soil.—E. **Fichot**: The sense of rotation of cotidal lines round amphidromic points.—M. **Siegbahn**: The degree of exactitude of Bragg's law for the X-rays. Exact measurements have shown that calcite gives a small deviation from Bragg's theory, the differences although small being systematic. M. Dauvillier has recently suggested that the deviation was due to the complexity of the $K\alpha_1$ line used in the measurements; but the result is the same for the line α_2, which according to M. Dauvillier is simple.—E. **Gleditsch** and B. **Samdahl**: The atomic weight of chlorine in an ancient mineral, Balme apatite.—J. **Durand**: The thermal treatment of some cast irons. Heating to 900° C. and slow cooling increased the proportion of graphite and diminished the resistance to breaking. Tempering in oil from 900° C. and repeating to 650° C. increased the breaking load.—M. **Charriou**: The separation of ferric oxide and alumina from lime by the nitrate method.—H. **Gault** and T. **Salomon**: The α-alkyl levulinic acids.—E. **Decarrière**: The *rôle* of gaseous impurities in the catalytic oxidation of ammonia. Extremely minute proportions of hydrogen phosphide (0·2 parts per million) poison the platinum catalyst in this oxidation, but the simultaneous presence of acetylene and hydrogen sulphide, especially the latter, partially neutralises the poisonous action of the phosphorus compound.—E. **Grandmougin**: The acyl and alkyl leucoindigos.—C. **Jacob**: Eruptive rocks of the intermediate series in North Annam and in Tonkin.—P. **Corbin**: Some sections on the eastern edge of the Vercors-massif.—L. **Guillaume**: Tertiary and existing Turritella: evolution and migrations.—P. **Lesage**: The determination of the germinative faculty other than by the actual germination of the seeds. A. Němec and F. Duchon have recently described a method based on the evolution of oxygen by the action of hydrogen peroxide on the diastase of the seed as the only method available for testing the vitality of the seed other than actual germination tests. The author directs attention to a method described by him in 1911 and 1917 based on the colour imparted to dilute solutions of potash by the seeds. This gives a definite result in four hours.—J. **Bouget** and A. D. **de Virville**: The influence of the meteorology of the year 1921 on the reddening and fall of leaves.—R. **Poisson**: Histogenesis of the flight muscles in Ranatra, Nepa (*N. cimicoides* and *N. maculatus*).—G. **Bourguignon**: Modification of the chronaxy of the skeleton muscles and their nerves by the repercussion of the lesion of the neurones with which they are functionally associated.—A. **Lumière** and H. **Couturier**: Traumatic shock.—C. **Levaditi** and S. **Nicolau**: The embryonic leaflets in relation with the affinities of the vaccine virus.—E. **Fernbach** and G. **Rullier**: The action of an artificial gastric juice on tubercular pulmonary granulations of the guinea-pig.

Academy of Sciences, March 20.—M. Emile Bertin in the chair.—A. **Haller** and Mme. **Ramart-Lucas**: New distinctive characters of the three propanol-α-camphocarbonolides melting at 141°, 117°-118°, and 89°-90° C. respectively.—G. **Mittag-Leffler**: Cauchy's theorem on the integral of a function between imaginary limits.—C. **Sauvageau** and G. **Denigès**: Remarks on the efflorescences of *Rhodymenia palmata*. The presence of a xylane in these algæ. The pentosane extracted by the method of Mme. Swartz from *R. palmata* gives xylose on hydrolysis and hence is a xylane. This is the first case of the extraction of this substance from an alga.—J. **Drach**: The determination of the differential equations of the second order integrable by quadrature.—G. **Julia**: The transformation of rational substitutions into linear substitutions.—M. **Stoïlow**: The definite integral and the measurement of *ensembles*.—J. **Ubach**: Observations of the partial eclipse of the sun of October 21, 1921, made at Buenos Ayres (Argentine Republic).—F. **Michaud**: A micromanometer with sensibility capable of regulation.—A. **Guillemet**: A new objective shutter for taking aerial photographs with apparatus with long focus.—V. **Henri**: The absorption spectrum of benzine vapour and the fundamental magnitudes of the benzine molecule. The absorption spectrum of benzine vapour has been measured at pressures between 0·01 and 65 mm. The ultra-violet spectrum can be represented very exactly by a formula derived from Bohr's theory, and consists of four series of superposed bands. The results show that the molecule of benzine is a very symmetrical structure, the movements of which obey the simple laws deduced for diatomic molecules.—F. W. **Klingstedt**: The ultra-violet absorption of phenol in different solvents. The absorption spectrum of phenol in solution depends on the nature of the solvent. Comparing with the spectrum of the vapour, one type of solvent (carbon tetrachloride and ether) produces only a displacement and enlargement of the bands. The second group of solvents (methyl and ethyl alcohol, and water) change the absorption spectrum completely. The spectrum of pure liquid and solid phenol is intermediate between the two preceding types.—C. **Chéveneau**: An optical method for the determination of the reciprocal solubility of slightly miscible liquids. The method is based on the use of a hollow prism divided into several compartments. The differences of the refractive indices of the two liquids are taken directly, independently of the temperature. The case of aniline and water is given and the results compared with the gravimetric method.—G. **Guilbert**: The observation of clouds and the prediction of weather.—H. **Joly**: The existence of phenomena of horizontal displacements of large amplitude at the eastern extremity of the Iberian chain, near Montalban (province of Téruel, Spain).—H. **Coupin**: Determination of the optimum of humidity of the external medium in the Oscillaria.—A. **de Puymaly**: The reproduction of Vaucheria by amœboid zoospores.—G. **Tanret**: The chemical composition of ergot of Diss (*Ampelodesmos tenax*) and the ergot of oats. Since the closing of the Russian frontiers ergot of rye has become extremely scarce, and the possibility of obtaining ergot from other Graminaceæ is of immediate interest. Of the two plants mentioned, oats only would appear to contain sufficient of the active principle to be of practical service. From one kilogram of Algerian oats 1·8 gram of crude and 0·8 gram of pure crystallised ergotinine was isolated.—C. J. **Gravier**: The relations between the Crustacean and the sponge in the sponges carrying Cirripedes.

Official Publications Received.

Spolia Zeylanica. Edited by Dr. J. Pearson. Vol. 12, Part 45. Pp. 221. (Colombo: Colombo Museum.)

Department of Statistics, India. Agricultural Statistics of India, 1919–20. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment, and Harvest Prices in British India. (Thirty-sixth issue.) Pp. ix+380+9 charts. (Calcutta: Government Printing Office.) 2.8 rupees.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1920. Pp. iv+32. (Barbados: Imperial Commissioner of Agriculture for the West Indies.) 6*d*.

Union of South Africa. Fisheries and Marine Biological Survey. Report No. 1 for the Year 1920. By Dr. J. D. F. Gilchrist. Pp. v+111+9 plates+4 charts. (Cape Town: Cape Times, Ltd.)

Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1921. Pp. 219. (Washington: Government Printing Office.)

State of Connecticut: Public Document No. 24. Forty-fourth Annual Report of the Connecticut Agricultural Experiment Station: Being the Annual Report for the Year ended October 31, 1920. Pp. xvi+377. (New Haven.)

Diary of Societies.

FRIDAY, APRIL 21.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—J. K. Bruce: The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost under given Conditions.
INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—J. R. Smith: Electricity in a Machine Shop.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—S. A. Stigant: Condenser and Coke Coil Protective Apparatus.

MONDAY, APRIL 24.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Repair.
ROYAL INSTITUTE OF BRITISH ARCHITECTS (at Olympia), at 6.—Prof. P. Abercrombie: What we mean by Town Planning.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—B. A. C. Hills: Jigs and Tools.
ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. H. Mummery: Dental Diseases in Ancient Egypt, demonstrating some Photographs forwarded by the late Sir Armand Ruffer.—E. Sprawson: (1) A Case of Multiple Follicular Odontomes (Dentigerous Cysts) in the Mandible, and some Remarks as to the Pathology of such Cysts. (2) The Significance of the Extra Cusp commonly found in the Antero-internal Aspect of the Maxillary First Permanent Molar in Man.

TUESDAY, APRIL 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II. Racial Problems of Africa (1).
ROYAL SOCIETY OF MEDICINE (Medicine Section) (at Middlesex Hospital), at 5.—Clinical Meeting.
ROYAL STATISTICAL SOCIETY, at 5.15.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of March 1922.—R. J. Ortlepp: A New Species of the Nematode *Œsophagostomum* from the Rodent *Xerus setosus*.—Dr. C. F. Sonntag: The Anatomy of the Drill (*Mandrillus leucophæus*).—Dr. R. Broom: The Persistence of the Mesopterygoid in certain Reptilian Skulls.—A. Loveridge: New Reptiles from Tanganyika Territory.
INSTITUTION OF CIVIL ENGINEERS (Annual General Meeting), at 6.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Annual General Meeting), at 7; at 7.30.—Dr. T. S. Price: Gelatine.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.
ROYAL GEOGRAPHICAL SOCIETY (at Queen's Hall), at 8.30.—Lieut.-Col. C. K. Howard-Bury: The Mount Everest Country and People.

WEDNESDAY, APRIL 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. D. H. MacGregor: Industrial Relationships (1). The Historical Interpretation.
ROYAL INSTITUTE OF BRITISH ARCHITECTS (at Olympia), at 6.—Sir Lawrence Weaver: Modern Domestic Architecture; Fashion and Style.
ROYAL SOCIETY OF ARTS, at 8.—Dr. J. F. Crowley: The Uses and Advantages of Electric Power in the Factory, as illustrated by its Application to the Jute Industry.

THURSDAY, APRIL 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. H. Barton: Audition and Colour Vision (1). The Resonance Theory of Audition.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. Octavia Lewin: The Natural Defences of the Upper Air Passages.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. A. Kuyser: Protective Apparatus for Turbo-Alternators.
CONCRETE INSTITUTE (Annual General Meeting), at 7.30.—W. N. Twelvetrees: Reinforced Concrete Piers and Marine Works.
OPTICAL SOCIETY (at Imperial College of Science and Technology, South Kensington, S.W.7), at 7.30.—Prof. A. Pollard: The Mechanical Construction of the Microscope, from a Historical Standpoint.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 2 Furnival Street, W.C.1).—F. H. Jennison: Studies of Precipitation.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Discussion on the Use of Light in Hospitals (including the illumination of hospital wards and operating-tables and some other applications of light).
HARVEIAN SOCIETY (at Town Hall, Paddington), at 8.30.—Discussion, by Sir Humphry Rolleston and others, on Influenza.
ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—J. Swan and others: Tests of Renal Function.

FRIDAY, APRIL 28.

ZOOLOGICAL SOCIETY OF LONDON, at 4.—Anniversary Meeting.
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. G. Royal Dawson: The Need of an All-India Gauge Policy.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—T. Smith: The Position of Best Focus in the Presence of Spherical Aberration.—F. Twyman and J. Perry: The Determination of the Absolute Stress-variation of Refractive Index.—C. J. Smith: An Experimental Comparison of the Viscous Properties of (*a*) Carbon Dioxide and Nitrous Oxide, and (*b*) Nitrogen and Carbon Monoxide.—F. Twyman: Demonstration of the Optical Sonometer.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating the Forms of Inguinal Hernia.
ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Sir Robert Jones: Presidential Address.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E. G. Coker and Dr. K. C. Chakko: An Account of some Experiments on the Action of Cutting Tools.
ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. F. Dittmar: Outbreaks of Enteric Fever associated with Carrier Cases.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. Harden: Vitamin Problems.

PUBLIC LECTURES.

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

WEDNESDAY, APRIL 26.

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (1).

THURSDAY, APRIL 27.

UNIVERSITY COLLEGE, at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (1).—A. T. Walmisley: The Bridges over the River Thames at London.

FRIDAY, APRIL 28.

BEDFORD COLLEGE, at 5.15.—Prof. E. Claparède: L'Intelligence et la Volonté (1). (In French.)
KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (1).

CONTENTS.