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Science and Religion.

THE assembly of the Conference of Modern Churchmen at Oxford at the end of last month, and the adoption of the subject "The Scientific Approach to Religion" as the theme of the discussions, seem to suggest the present as an opportune moment for reconsidering the old question of the relation between scientific and religious doctrine. The atmosphere of this clerical conference was totally different from that of other ecclesiastical congresses where scientific questions have been under discussion. There was an almost complete absence of traditional presuppositions—in fact, there seemed to reign a determination to get back to first principles, and build upon the same foundation as that on which scientific teaching is based, namely, the ultimate nature of things—in a word, the structure and meaning of the universe.

The functions of religion and science are different both theoretically and practically, but it seems to us that both are equally necessary for the welfare of the human race. Religion differs in its theoretical aims from science, because the aim of science is the constant pressing forward to the discovery of new truth, whilst that of religion is the holding fast and transmitting to posterity of truth that has already been ascertained. On the practical side, the object of science is to adapt man ever more closely to his environment, and, so far as he can master it, to adapt the environment to him, whilst that of religion is to furnish the sanctions for the laws which hold society together. It may perhaps be objected that the delights of scientific investigations are able to support the man who pursues them in all the troubles of life without any assistance from religion whatever. This is undoubtedly true, but it does not carry us very far. For scientific work is impossible except in the environment of a civilised society, and the carrying on of such a society implies the performance of a great deal of monotonous and uninteresting work. The attempt to crush religious belief, and thus to persuade those who perform this work to persevere in the absence of the comfort and hope supplied by the Church, has proved a disastrous failure every time that it has been attempted. We have just witnessed the last of these attempts, that of the Bolshevists in Russia, which has resulted in consequences patent to all the world.

The conference was opened by an address by the president, the Very Rev. W. Inge, Dean of St. Paul's, who is distinguished above most other Churchmen by his knowledge of and sympathy with science, and it was closed by a sermon delivered by Canon Barnes, Bishop-designate of Birmingham, who was an eminent

scientific man and a fellow of the Royal Society before he entered the service of the Church.

If religious beliefs are founded on an ineradicable element in human nature, then nothing can be more disastrous than an irreconcilable cleavage between these beliefs and the teachings of science. It is, as Dean Inge said, an "open sore," and he added that to contribute in some measure to the healing of the sore was the main object of the conference. But religious truth is necessarily expressed in terms of the "Weltanschauung" of the period at which it was first promulgated. This "Weltanschauung" is just the science of the time, and as it becomes changed the religious truth is left embedded in a setting of outworn ideas. The aim, therefore, of the reconciler must be to extract the "timeless element" in religion from this setting and express it, so far as possible, in a pure and unadulterated form. This element Dean Inge finds in the "values"—goodness, truth, and beauty. These he declares to be the most real things in the universe: from their permanence he deduces not only the existence of God in whom they are completely realised, but also the permanence of those elements in us which respond to these values and seek for their complete expression.

Profs. Haldane and MacBride were invited to the conference as respectful and sympathetic outsiders, in order to state as clearly as possible the modern positions on vitalism and evolution. Prof. Haldane emphatically asserted that the action of living beings cannot be explained upon mechanical principles—it is theoretically possible to construct a series of imaginary machines the working of which will simulate more or less closely the actions of living beings; but as our knowledge of the details of these actions grows, so the machines become more and more complicated—and the futility of the whole procedure is shown by the fact that no account whatever can be given of the "mechanism" by which these machines come into being or how these supposed intricate structures emerge from the egg. Prof. MacBride pointed out that the acceptance of evolution necessitated the entire recasting of the Mosaic cosmogony and of the doctrines of sin and the fall set forth by St. Paul, and he also directed attention to the great outstanding difficulty in the way of any theory of a beneficent Author of the universe, namely, the cruelty and carnage involved in the elimination of the unfit. On the other hand, whilst giving a résumé of the well-known evidence for animal evolution, Prof. MacBride pointed out that "natural selection" gives no explanation of the process any more than the pruning-knife can account for the forces of growth in the plant; that the driving force of evolution is the power of the living being to rise up to meet adverse circumstances and, by adapting itself to them, to overcome them; and that the powers acquired by the parents are transmitted to the children. Evolution, therefore, in the proper sense, is a vital phenomenon which can be exhibited only by living beings, and to use it to include the physical and chemical processes involved in the cooling of a heated globe, for example, as did Herbert Spencer, is to empty it of its essential meaning. In principle, therefore, Prof. MacBride and Prof. Haldane agreed.

The president in his opening address had touched on the limitations of scientific explanations. Science knows nothing of origins or ends but only of processes. In a rigidly defined mechanical system, change and adaptation are impossible; moreover, if the cosmos as a whole is regarded as a mechanical system, then it is not self-explanatory, for it is not a static system but is "running down." No reason can be assigned why it should not have already reached equilibrium if we postulate an indefinite period of past time. There must be something permanent behind it—and this something which the religious soul quests for, and to which it believes itself to be akin, is God. Prof. De Burgh's paper connects at this point with Dr. Inge's address; for he dealt with the stupendous subjects of God, time, and eternity. In a most brilliant essay he pointed out that the idea of time as a mere flux of vanishing "nows" is inconceivable and self-contradictory—that there must be a permanent basis underlying it, and this permanent basis he identified with eternity. He thought that whilst an "Absolute" of some kind was a necessary postulate of reason, we required the religious experience to convince us of the existence of God. This we think rather dangerous reasoning. The word "God" is just the name given by the plain man to the reality behind the complex of circumstances surrounding him, by which he is limited and controlled. He is conscious of strong desires, and conceives purposes in the execution of which he is frequently frustrated; therefore in the world around him there is an "other" to which he is frequently opposed. On any theory of evolution his own nature and personality have somehow been evolved out of this "other." Can the stream rise higher than its fountain? "He that planted the ear shall He not hear?"

Of course, it may be objected that these searches for the ultimate, these aspirations after union with the divine, can never give us anything but pleasant dreams, whereas science supplies us with solid facts on which we can depend. This contrast between the certainty of science and the vagueness and uncertainty of religion sounds obvious, but we are not at all sure that it will stand critical examination. After all,

what are "facts"? "The ordinary man," said that acute philosopher McTaggart, "thinks that he knows facts; but when we analyse these 'facts' they turn out to be a compound of sensations and thoughts." It is vain for the physiologist to point out that consciousness appears in Nature as a mere epiphenomenon associated with the chemical changes in certain organic compounds. When he uses reasoning like this, he implicitly separates his own reason and perception from the rest of the world, and views the workings of other conscious beings from the outside. "I cannot conceive of matter," said the candid Huxley, "apart from mind to picture it in." To quote another Cambridge philosopher: "From one point of view consciousness appears a temporary phenomenon associated with certain forms of matter, but when we look at it from another point of view it swallows everything else. Both views are true, and we do not realise what a wonderful universe we dwell in till we have grasped this fact."

Religion is sometimes regarded from the evolutionary point of view as a defence mechanism which has been brought into being to support and encourage the communal life of the tribe, but reason and its product scientific knowledge may, with equal justice, be regarded as a food-getting mechanism evolved to enable us to feed ourselves, and in no way to be considered as capable of giving us accurate information about the universe. Indeed, if we for a moment assume the validity of our own sensations and view our fellow-man from without, what ground have we for supposing that his sensations will give him any accurate picture of the world around him? How can a vibration in the ether impinging on a retinal cell and setting up therein chemical changes which result in the "stimulation" of a nerve cell, and the transference of this "stimulation" to the brain, give any information as to the nature of the body from which the vibration proceeded? Yet, if we do not make this assumption, there is an end to science. If we, therefore, following our natural instincts, trust our senses to tell us what the universe is like, why should we not trust our religious instinct as to the kinship between our own spirits and the Ultimate Reality? The question, therefore, of the "validity" of our knowledge must be separated from all speculations as to its evolutionary origin.

The fundamental difficulty of the whole situation is that the man of science and the philosopher alike strives each to construct a complete system to include the whole universe. The humbler and more correct attitude is that of Huxleyan agnosticism, which, as Prof. MacBride pointed out at the conference, is entirely compatible with the Christian faith; for this faith is a determination to stake everything on the hope that the "values" will turn out to be real and eternal. In the obituary notice of Huxley published in NATURE and written by his pupil, Sir Michael Foster, there appears the sentence, relating to the problem of the survival of the soul, "Huxley was convinced that science could never with all its endeavours avail to raise one corner of the veil concealing that dream by which our life is rounded."

Perhaps we may best sum up the whole matter in the words of that scientific theologian, Harnack:

"In spite of intense effort our modern thinkers have not succeeded in developing a satisfactory system of ethics and one corresponding to our deepest needs on the basis of monism. They will never succeed in doing so. If this be admitted it is in the last resort a matter of indifference with what names we designate the two sides of the dualism which, as moral and thinking men, we encounter—for instance God and the World, Here and Hereafter, Visible and Invisible, Matter and Spirit, Necessity and Freedom. Unity can be *experienced* and one side can be subordinated to the other, but this unity is always reached by a struggle in the form of an endless problem which can only be approximately solved, and never by the refinement of a mechanical process. We are not able to bring our knowledge of time and space into the unity of a consistent Weltanschauung with our inner life. Only in the peace of God which is higher than all reason can we catch a glimpse of their ultimate unity."

The Rarer Elements.

Chemistry of the Rarer Elements. By Prof. B. Smith Hopkins. Pp. vii + 376. (Boston, New York, Chicago, and London: D. C. Heath and Co., 1924.) 15*s.* net.

THE reader's interest will be aroused even before he has opened this volume; for he will doubtless be curious to learn which members of the elemental series the author has decided to group together under the rubric of "rarer elements." The preface furnishes a satisfactory definition. Prof. Hopkins has taken as his province "those elements which are little known either because of scarcity, neglect, or ignorance." His object has been "to call attention both to the advances which have recently been made in our knowledge and also to the need of further research in the development of many of the less familiar elements."

It must be confessed that, to the non-specialist, many of the books hitherto written about the rarer elements are more than a little dry. Before opening them, the would-be reader has a foreboding—often justified in the event—that he will find within the covers simply the usual accumulation of facts carefully grouped under certain set headings: facts, individually

important, which seem to resist any attempt to force them into any far-reaching and logical scheme. This apparent incoherence of the data attains its culmination in the case of the rare earth group, where, although the proper elemental sequence is indisputable, no generally accepted system has yet been evolved which will bring the elements into line with each other or with the remaining forms of matter which we know.

There is another pitfall in the path of a writer upon the rarer elements. Owing to the fact that he is making an arbitrary selection from the material, he runs a grave risk of isolating the elements with which he deals from their commoner brethren; and in this way he tends to produce the impression that these rarer elements stand in a class by themselves, that gallium, for example, is in some mysterious way to be mentally segregated from the remainder of its group.

Prof. Hopkins's book avoids both of these difficulties. He gives the reader a general description of the salts of each of the elements with which he deals; but he has resisted the temptation to insert data simply because they are known. The result is that his book holds the reader's interest without difficulty, even in those places where dulness might be expected to supervene.

Even more praiseworthy is the fact that he never allows the student to forget the relations existing between the elements as a whole and the particular one which is under discussion. The book opens with a chapter on the Periodic System, in which some of the recently suggested forms of the Periodic Table are described and the possibility of further discoveries of new elements is examined. This forms the frame into which the rarer elements are fitted one by one. But, in addition to this, each section of the book is headed by an excursus in which a general survey is made of the group containing the special rare elements under discussion in that section. Thus the peculiar mental partition between the "rarer" elements and the "commoner" elements is never allowed to grow up in the mind of the student.

Another feature which makes the book specially valuable to the student is the way in which the practical importance of the rarer elements is emphasised in detail; for in some books the impression is left that these substances are mainly of academic interest. Prof. Hopkins, without overloading his pages, has succeeded in tracing the ramification of these rarer elements into commercial practice; and his chapters cannot fail to suggest that we are as yet only on the frontier of a great development. As a rule, the author deals in turn with the history of the element, its occurrence in Nature, its extraction and metallurgy, its properties, its uses, and he terminates his sections with brief descriptions of the more important compounds and the methods whereby they may be identified.

The publication of books of this type seems to be one of the hopeful features of modern chemical literature. In the past there was an appreciable gap between the college text-book on one hand and, on the other, the German compendium in six or more volumes which generally, with quite unconscious humour, was entitled a "Hand-book"; and the student who had just mastered the elements was apt to be intimidated when faced with his next step in the literature of his subject. Nowadays, with excellent series of monographs from British and American publishers, the student is much better off. He can get his information on certain subjects without having to wade laboriously through huge systematic "text-books." Thus he is able to attain a reasonable standard of knowledge without being discouraged by the forced realisation of how much he does *not* know; while at the same time his interest is sharpened and he is encouraged to go forward in the pursuit of a more complete knowledge. Chemistry, with all its modern ramifications, has long passed the stage when any one except the mere book-worm can pretend to "know" the whole of it in detail; and the recent trend in chemical literature away from the cast-iron systematic text-book has been all in the interest of the student who has just completed his course and is looking forward to extending his knowledge. Books like this of Prof. Hopkins are to be welcomed. A. W. S.

Geology of the United States.

A Text-Book of Geology: for Use in Universities, Colleges, Schools of Science, etc., and for the General Reader. By Prof. Louis V. Pirsson and Prof. Charles Schuchert. Part 2: *Historical Geology.* By Prof. Charles Schuchert. Second, revised edition. Pp. ix+724. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 22*s.* 6*d.* net.

ORIGINALLY published nine years ago, Pirsson and Schuchert's Text-book has become the most popular introduction to geology among American students, and its well-merited supremacy is now likely to be still more firmly established by the issue of a second edition in which it has been thoroughly revised and brought up-to-date. The first volume, by the late Prof. Pirsson, deals with physical geology and is naturally of wider interest than the second part—now under review—in which Prof. Schuchert lucidly sets forth the principles of stratigraphy and palæontology, and the broader features of the geological history of

the United States. Compared with its first edition, the second volume is now increased by about eighty pages, a series of palæogeographical maps have been introduced, and the Ozarkian has disappeared as a system, the formations known by that name being now regarded as the closing epoch of the more familiar Cambrian. Eozoon is still thought to represent the earliest known evidence of calcareous algæ. As in the first edition, there are no detailed references, but this defect is met by appending to each chapter a list of suggestions for further reading. It is worthy of notice that British work has not been neglected as it so often is in American books. Moreover, the Period names are retained for the most part in their original forms, and such terms as "Permic" are happily given no support.

The treatment of the work as a whole is very much broader than the title indicates, for interspersed with the stratigraphical chapters there are just as many dealing with palæontology. These, with others of general interest, on such topics as astronomy, biology, and evolution, make up a composite course of about forty-five lectures.

In teaching historical geology, it is logically but unfortunately necessary to plunge straight away into the intricate labyrinth of the Archæan; to start as closely as possible to that vague "beginning" of which Hutton could find no certain trace. The difficulty is one, however, that can be fairly met and overcome. But sound scientific method becomes impossible when the subject is made to begin with the origin of the earth and its "pre-geological" history. These are problems that belong more properly to geophysics, problems which will be attacked with success only when the earth's age, its thermal history, the origin of the continents, and other fundamental questions have been solved with a greater degree of confidence than is yet possible. It will nevertheless be refreshing to British readers to find that the influence of the planetesimal hypothesis and of its author's more personal opinions is now apparently steadily waning. This is mainly the result of criticisms by Daly and Barrell, the latter, before his lamented death, having clearly influenced the teaching of the book. Although no mention is made of the work of Harold Jeffreys (whose new book on geophysics leaves no excuse for that omission in future), the conclusion that the earth must have passed through a fluid state is accepted for other reasons.

A very interesting chapter deals with the perennial question of the permanency of the continents, but the problem of their origin is not solved by the speculations offered. The difficulty is essentially to explain the lateral differences of density between the lighter continental and the heavier oceanic segments of the earth's crust. It is suggested that heavy flows of widespread magma broke through the crust over wide areas and caused them to subside into ocean basins; but unless the magmas were very much more dense than we have any reason to suppose, the new surface would be no lower than the original one, and the vertical distribution of densities would be unstable in a way that should since have disclosed itself in the petrology of the oceanic igneous rocks. Pushing the light rocks down to great depths does not solve a problem, which is one of lateral, not vertical, differences.

Other general chapters deal with coal, petroleum, geological climates of the past, man's place in Nature, and the age of the earth. Joly's recent views based on pleochroic haloes are referred to but not accepted. Schuchert concludes that the hour-glass of denudation and sedimentation has not been read correctly by the majority of geologists in the past, and that the earth is at least 500 million years old.

Regarded as a college text-book, perhaps too much space is devoted to speculative matters and not enough to the economic resources of the systems or the igneous history of the continent, though these aspects of the subject are by no means wholly neglected. The stratigraphical chapters naturally take their main inspiration from the country of the author, and little attempt is made to correlate with Europe. The appeal of the book is therefore limited from the point of view of the British student, for whom, indeed, it is unsuitable as a text-book. It is, however, full of ideas for teachers of the subject; it may be confidently accepted as the most up-to-date and authoritative summary of the geology of the United States; and it is consequently worthy of a place in every reference library.

ARTHUR HOLMES.

Co-ordination of Numerical Data.

The Calculus of Observations: a Treatise on Numerical Mathematics. By Prof. E. T. Whittaker and G. Robinson. Pp. xvi+395. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 18*s*. net.

A SET of numerical data, whether obtained from theory or experiment, gives rise to mathematical problems of interest and importance. The consideration of these problems now forms an important branch of pure mathematics: apart from this, some knowledge of them is required by workers in many fields —astronomers, meteorologists, physicists, engineers, naval architects, actuaries, biometricians, and statisticians. Until recently the subject has received but little attention in the mathematical departments of

British universities. During the last ten years, however, interest in it has been thoroughly aroused, especially in the Universities of London and Edinburgh. To Prof. Karl Pearson, head of the Department of Applied Statistics at University College, London, is due the credit of organising a mathematical laboratory for dealing systematically with numerical problems. During the War, Prof. Pearson's laboratory was occupied with numerical work on ballistics: more lately it has produced a series of tracts on computation. In Edinburgh, Prof. E. T. Whittaker has also organised a mathematical laboratory, and the volume before us may be regarded as a manual of the methods that have been evolved there.

The first four chapters, on interpolation and difference formulæ, are also published as a separate tract under the title "A Short Course in Interpolation" (price 5*s*. net). To a mathematician this section is much more convincing than those accounts of the subject which aim primarily at the application of interpolation to engineering or actuarial work. In particular, the important chapter on divided differences has not, we think, appeared before in any English book. Some of the early worked examples involve fifteen-figure numbers, and seem unnecessarily heavy: all the principles at stake could be amply illustrated by numbers of seven or eight digits.

The long sixth chapter gives an account of many useful methods of obtaining the numerical solution of an algebraic or transcendental equation. In numerical work, Horner's process of successive approximation is often found to be less useful than the root-squaring method of Graeffe. Graeffe's method, unlike Horner's, is easily adaptable to the location of complex roots—a problem the importance of which has greatly increased of late through its occurrence in determining the stability of an aeroplane. When an algebraic equation has only one or two pairs of complex roots, Graeffe's method is sufficient to isolate them without difficulty. A recent modification of the method, due to Prof. Brodetsky and Mr. Smeal, enables any number of complex roots to be located: we hope that this discovery will be added to the next edition of the work under notice.

Only the first seven chapters will normally be read as part of a university undergraduate course. A separate volume containing this part of the work alone would appeal to a wide class of readers. The rest of the book, from Chapter viii. onwards, forms an introduction to the mathematical theory of statistics, which, normally, will be read only by graduates engaged on research. Compared with the first seven chapters, this part of the work is too heavy, and the introductory matter leading up to it is inadequate.

When the Edinburgh laboratory was founded in 1913, a trial was made, so far as possible. of every method which had been proposed for the solution of the problems under consideration, and many of these methods were graphical. During the ten years that have elapsed since then, the graphical methods have almost all been abandoned, as their inferiority has become evident, and at present the work there is almost entirely arithmetical. No previous book in any language contains the matter collected here after ten years' experience of dealing with numerical data. The authors are to be heartily congratulated on successfully producing a book that gives the result of so much pioneering work. W. E. H. B.

Our Bookshelf.

Emergency Water Supplies for Military, Agricultural, and Colonial Purposes: Based on Experience of the Mediterranean Expeditionary Force Operations, with Special Reference to the use of Drive Tube Wells and Drilling. By A. Beeby Thompson. Pp. xii+180+45 plates. (London: Crosby Lockwood and Son, 1924.) 21*s*. net.

POSSIBLY no problem is of such vital importance to the pioneer and settler as that of the location of a suitable source of water supply for drinking and potable purposes; scarcely less inevitable is the problem in connexion with military incursions into countries which are destitute of uncontaminated surface supplies and ill-suited for overland transport. Therefore, to all classes of adventurers and explorers, whether prospecting, colonising, or expeditionary, Mr. Beeby Thompson's book, with its valuable record of methods and contrivances used in connexion with the Mediterranean Expeditionary Force operations, will come with welcome interest, affording much practical precept and useful advice.

Upon diviners or dowsers, Mr. Thompson looks with sceptical eyes. He allows some to be honest, but is frankly suspicious of them all and their methods. Their inconsistencies, not less than their failures, fill him with distrust; yet he is not above letting them have a trial. "In the absence of any definite scientific reason for locating a well at a particular spot, the dowser could be given his chance, and to the author's knowledge the location of small supplies has resulted on several occasions." Mr. Thompson is certainly fair.

The book proceeds, however, on a more scientific basis than any which governs the dowser in his prognostications. The origin of water is discussed, the incidence of rainfall, the amount of run-off, the level of water tables, sources of potable water, and the value of hygienic measures; and thereafter follows a series of chapters on the driving of tube wells, drilling operations, pumping equipment and water analysis, with illustrations from actual experience in Bulgaria, Serbia (why does the author write Servia?), Macedonia, and elsewhere. Full of practical direction and experimental information, the book should be a valuable guide to all

who seek water supplies in unexplored or undeveloped regions.

Mr. Thompson comments on a fact which he states attracted notice and inquiry during the War, namely, "the comparative permanence of springs high up on mountain ranges after long periods of drought when those lower down commenced to fail," and he advances five reasons, separately or collectively, to account for the phenomenon. It would be interesting to know the extent to which this characteristic was observed and whether it was so general as to be really remarkable.

BRYSSON CUNNINGHAM.

The Plant Alkaloids. By Dr. T. A. Henry. Second edition. Pp. viii+456+8 plates. (London: J. and A. Churchill, 1924.) 28*s.* net.

WHEN Dr. Henry published the first edition of his "Plant Alkaloids" ten years ago, general satisfaction was felt and expressed at the appearance in English of a really comprehensive work on so important a subject, and at the masterly way in which the author had dealt with it. Since then, notwithstanding the general interruption of such work due to the War, many investigations have been made and many researches published on the isolation, constitution, and properties of the alkaloids. One need only mention such examples as the investigation of the alkaloids of ergot, opium, areca nut, pomegranate bark, belladonna, cinchona, Calabar bean, ipecacuanha, yohimbe bark; of the oxidation products of brucine by Leuchs and his collaborators, of the constitution of chelerythrine by Karrer, of chelidonine by Gadamer, and so on, to realise the immense amount of material that Dr. Henry had to examine critically and sift in the preparation of the second edition of his work. He has succeeded admirably. Researches published in the spring of this year have received attention, although it may not have been possible for him to deal with them so fully as he may have desired.

Notwithstanding the large amount of fresh material to be dealt with, the size of the volume has not been increased, as that which had been superseded has been omitted as unnecessary. Methods of determining the percentages of alkaloids in drugs have received rather less attention than formerly, and rightly so; indeed, it is rather to be doubted whether these could not in the future be relegated entirely to the books that make such assays the subject of special attention. On the other hand, rather more space has been devoted to the discussion of such information as is available on the relation of chemical constitution to pharmacological action, a subject of surpassing interest but one in which it is not yet possible to draw general conclusions. The six pages given to the pharmacology of the tropane group is a good example of the clear and concise manner in which the author deals with this difficult problem.

Dr. Henry is to be congratulated on the successful accomplishment of his task. All who are interested in plant chemistry in general, or in the plant alkaloids in particular, will be glad to have at their disposal a work of reference that is thoroughly up-to-date and as trustworthy in its information as it is possible for such a work to be.

Handbook of the British Flora: a Description of the Flowering Plants and Ferns Indigenous to, or Naturalised in, the British Isles; for the Use of Beginners and Amateurs. By George Bentham. Revised by Sir J. D. Hooker. Seventh edition, revised by Dr. A. B. Rendle. Pp. lxi+606. (London: L. Reeve and Co., Ltd., 1924.) 12*s.* net.

THE publication of a new edition of Bentham's "Handbook of the British Flora" is of considerable importance to students and teachers of botany in Great Britain. There is no published work which better serves as an introduction to the British flora than this, and, though it can be strongly urged that we now need a completely new "Handbook," approximately on the lines of Schinz and Keller's "Flora der Schweiz," it is a good thing that the republication of Bentham and Hooker's Handbook has not been undertaken without a revision.

Dr. Rendle has most decidedly improved the work, and in many respects has made it more in accordance with modern knowledge and usage. The nomenclature now approximates—after allowing for very considerable differences in species standards—closely to that of Babington's "Manual" (10th edition). The chapter in the introduction on vegetable anatomy and physiology has been omitted, the etymology of generic names and indications of pronunciation have been added, while certain improvements have been made in classification, particularly of the Cryptogams. Descriptions of the relatively few additions, since the last revision, of "Benthamian species" to the British flora are inserted, and bibliographical references are given to some of the more important recent researches on the critical genera. In spite of these improvements, it seems a pity that the very "large" species standard has been retained even for the use of "beginners and amateurs." Modern field-botany tends so much towards ecology, and systematists often feel that the determination of species by ecologists is none too critical, that the need of a handbook with complete keys and adapted for field-work, but based on a conception of smaller, and often more actual, species, is greater than ever.

La Photographie des couleurs. Par Prof. J. Thovert. (Encyclopédie scientifique: Bibliothèque de Photographie.) Pp. viii+300+4 planches. (Paris: Gaston Doin, 1924.) 17·60 frs.

THE photography of colour is a subject that has been gradually growing in importance and extent during the last few decades, so that the time has come when it may well be treated of in more detail than is possible in moderate-sized manuals of photography in general. This volume is therefore a welcome addition to photographic literature. The author deals first with light and colour, including the transmission, refraction, diffraction, interference, and absorption of light, the production of spectra and their uses, and wave motion. The reproduction of colour by interference, dispersion, and by three-colour and two-colour methods follows, with practical instructions and theoretical considerations. Processes that have only a classic or historic interest are treated of sufficiently, but the special adaptation of methods to photomechanical processes is not included. The book is well and usefully illustrated, and has four good plates in colour.

Letters to the Editor.

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The Assignment of Lines and Term Values in Beryllium II and Carbon IV.

WE have already published briefly the methods by which we have recently been able to determine with certainty the degree of ionisation of the atoms giving rise to many of the lines of the spectra produced by our "hot sparks," and in the case of Boron III the method by which the "Term Values" have been worked out (Proc. Nat. Acad., May 15, 1924. See also forthcoming articles in *Physical Review* and *Phil. Mag.*).

The object of the present note is to make a preliminary report upon the application of the same methods to the determination of the chief characteristics of the spectra of the "stripped atoms" of beryllium and carbon (Be_{II} and C_{IV}).

TABLE 1.

BERYLLIUM II.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
1	1512·31	66124·0	$(2p_2-3d)$	$4f - 27438{\cdot}5\pm3$
2	1512·45	66117·9	$(2p_1-3d)$	$3d - 48826{\cdot}1\pm3$
1	1776·27	56297·7	$(2p-3s)$	$2p_1-114943{\cdot}7\pm3$
1	4675·6	21387·6	$(3d-4f)$	$2p_2-114950{\cdot}3\pm3$
?	3132·086	31927·60	$(2s-2p_2)$	$2s - 146877{\cdot}9\pm3$
?	3131·438	31934·21	$(2s-2p_1)$	$3s - 58649{\cdot}3\pm3$

TABLE 2.

CARBON IV.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
2	384·4	260166	$(2p-3d)$	$3d - 195333\pm30$
1	419·8	238197	$(2p-3s)$	$2p_1-455445\pm100$
4	1548·26	64588·6	$(2s-2p_1)$	$2p_2-455553\pm100$
4	1550·84	64481·2	$(2s-2p_2)$	$2s - 520034\pm100$
				$3s - 217302\pm100$

With the aid of the foregoing term values, and those which we have already published for stripped boron (B_{III}), it becomes possible to arrange tables for the stripped atoms Li_I, Be_{II}, B_{III}, C_{IV}, precisely similar to those which Pashen and Fowler have arranged for the series Na_I, Mg_{II}, Al_{III}, Si_{IV}. Such tables (3 and 4) follow.

TABLE 3.

$$(Z-s)=\sqrt{\frac{\nu \cdot n^2}{R}}.$$

(See equation 2, our paper "Some Conspicuous Successes of the Bohr Atom and a Serious Difficulty," forthcoming number *Phys. Rev.*

ν = term value.
R = Rydberg constant.
n = total quantum number.)

	2s.	$2p_1$.	3d.	4f.
Li . .	1·259040	1·020736	1·000437	0·999843
Be. .	2·313884	2·046944	2·001155	2·000200*
B . .	3·339489	3·064008	3·001886	3·000431
C . .	4·353908	4·074566	4·002600*	

TABLE 4.

	2s.	$2p_1$.	3d.	4f.
Li/1 .	43486·3	28582·5	12203·1	6856·1
Be/4 .	36719·5	28735·9	12206·5	6859·6*
B/9 .	33993·1	28616·1	12207·8	6860·2
C/16 .	32502·1	28465·3	12208·3*	
R/n^2 .	27433·0	27433·0	12192·3	6858·3

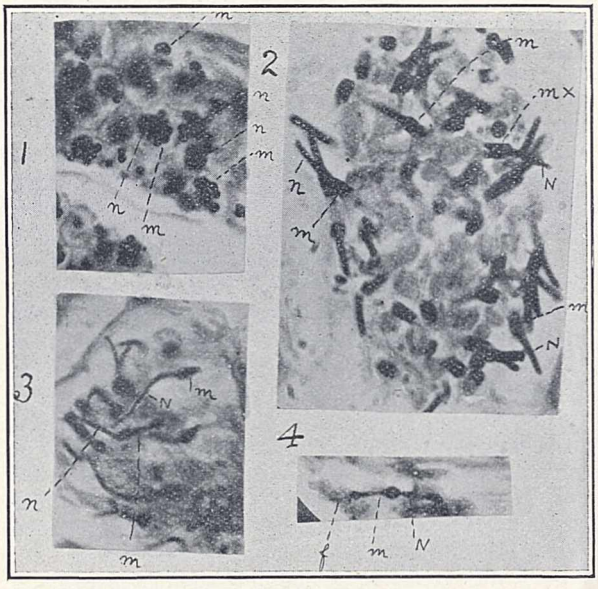
* Assumed.

R. A. MILLIKAN.
I. S. BOWEN.

Norman Bridge Laboratory of Physics,
California Institute, Pasadena, Calif., July 18.

The Scorpion Spermateleosis.

IN two recent letters to NATURE (July 12 and August 2) Mr. Vishwa Nath has referred to the results obtained by two of my students. Mr. Nath finds himself unable to support the statement of Prof. Bhattacharya and myself, that in the scorpion spermateleosis "the mitochondria form the sperm tail directly." It should be pointed out that the findings of Prof. Bhattacharya and myself directly support the previous work of Prof. E. B. Wilson, the distinguished American cytologist.



So far as we are concerned, our material is very clear and easy to study, and we feel sure that if Mr. Nath examines his slides more carefully, he will find that Wilson has given the correct interpretation of the scorpion spermateleosis.

Herewith we give four photomicrographs of our material. In Fig. 1 the mitochondrial spheres of the spermatids (*m*), after becoming partially fused, elongate to form a number of leaf-like structures (the mitosome, nebenkern, etc.), shown well at *mx* in Fig. 2. The nucleus at this stage elongates rapidly (N), while the leaf-like mitochondria further elongate to form a club-shaped structure (Figs. 3 and 4) which eventually, becoming more attenuated, forms the tail as claimed by Wilson. In Fig. 4 the nucleus, N, is partly out of focus, but joins the mitosome at *m*, and passes back to the axial filament (*f*), which is embraced by the residual protoplasm containing the Golgi bead.

Moreover, if the mitochondria are rejected, as Mr. Nath's letter suggests, one would expect to find evidence for this in the residual protoplasm, as has been done in pulmonate molluscs (Gatenby). If sloughing occurred at all in the spermatids overloaded with mitochondria, it could only apply to the very tail end, and certainly only after the middle piece had been formed directly from mitochondria.

Both Prof. Bhattacharya and I are hoping to demonstrate our material before the Royal Microscopical Society this winter session. We shall be very glad to see Mr. Nath there, and to witness his demonstration of tail formation in scorpion spermateleosis, by any method other than that described by Wilson and Bhattacharya and myself. Our paper on the scorpion spermatogenesis is being published in Prof. Gregoire's Jubilee Number of *La Cellule*.

With reference to Mr. Nath's observations on Miss S. D. King's letter on the "Oogenesis of Lithobius," I should say that Miss King has carried out her investigation under my supervision, and I have examined many of her slides. I feel sure that her account is the correct one. The scheme of oogenesis for Lithobius, worked out by Miss King, agrees with Hogben's previous researches on insect oogenesis, and broadly with my own work on Saccocirrus (Archiannelida).

Mr. Nath mentions that in "Saccocirrus (Gatenby)" the Golgi bodies undergo fatty degeneration. This is incorrect: what I did write was (*Q.J.M.S.* vol. 66, p. 15) that, "From the method and time of appearance of the fatty yolk, I believe it is formed from the Golgi bodies, but I admit it is impossible to make a trustworthy statement in such unfavourable material." The whole point of my Saccocirrus work was that the yolk is nucleolar in origin.

There is one point mentioned by Mr. Nath which is really of interest and value, provided his observations are correct, and I sincerely hope that they are. In a list of animal groups in which the mitochondria directly form the tail, Prof. Bhattacharya and I mentioned (NATURE, June 14): moths (Meves and Gatenby), cockroaches (Duesberg), annelids (Gatenby), scorpions (Sokolow, Wilson, Gatenby, and Bhattacharya), mammals (Duesberg, Regaud, Woodger, and Gatenby, etc. etc.), and certain molluscs also (Gatenby, etc.), and now Mr. Nath states that in his centipede the mitochondria directly form the tail. This is good news to me.

In many of Miss King's Da Fano preparations we found argentophile rings on the sperms. We have not yet worked at the spermateleosis, but I am much interested to read that Mr. Nath also finds Golgi bodies on the tails of the spermatozoa of his specimens. The only spermatozoa hitherto positively known to carry Golgi elements are those of Ascaris and Cavia, but there are other more doubtful cases. It will be curious if later work shows that the argentophile rings of the centipede sperms are really Golgi bodies.

Until Mr. Nath has the opportunity of reading Miss King's full paper, which will appear about Christmas in the Proceedings of the Royal Dublin Society, I feel that further comment will not be of advantage to cytology in general.

J. BRONTË GATENBY.
Trinity College, Dublin,
August 15.

Interpretations of Primitive American Decorative Art.

DR. H. O. FORBES in his communication on "Pre-Columbian Representations of the Elephant in America" in NATURE of August 2, p. 174, makes some statements on which I would like to offer comment. In his attempt to discover a basis in the Cephalopoda for the decorative *motifs* under discussion, Dr. Forbes states (p. 176) that "In the argonaut, the two central arms, when all are spread, are often so closely apposed as to appear a single very broad tentacle—a feature very conspicuous in the South Atlantic Bathypolypus." Now "central" arms can either mean the second and third of each side or possibly the first and last of both sides (the dorsal and ventral pairs). In either case Dr. Forbes's statement is inaccurate, so far as I can judge from the examination of numerous specimens and figures of Argonauta. The arms in question are not thus "closely apposed as to appear a single very broad tentacle." The statement seems to be likewise inapplicable in the case of Bathypolypus. This genus was founded in 1921 by Grimpe. It was not defined by him though he designated the type (*Octopus arcticus* Prosch). A definition prepared by myself, after correspondence with Dr. Grimpe, is in the press at the present moment. This genus includes *Octopus arcticus* Prosch, *faeroensis* Russel, *lentus* Verrill (N. Atlantic), and *grimpei* Robson (M.S.), and *valdiviæ* Thiele (S. Atlantic). It is doubtful at present what others should go into it. In any event, the two South Atlantic species have not the characters attributed by Dr. Forbes to the genus.

I may be doing Dr. Forbes an injustice. I may have overlooked in a recent fairly exhaustive search a large number of species having the character described by Dr. Forbes and transferred to Bathypolypus. If that is the case I should be very grateful for information concerning such cases.

With regard to the suggestion made by Dr. Forbes that the Maya and Copan sculptures can be interpreted as figures of highly conventionalised Cephalopods, I feel that the evidence is insufficient to sustain his theory. I admit that the Manabi slab (Dr. Forbes's letter, Fig. 1, p. 174) looks like a conventionalised squid, though I feel that careful examination would very much modify this preliminary impression (for example, if a squid, why *eight* arms ? ; ? meaning of the four arms or tufts on the "mantle" ; ? *circular* ends of arms). With regard to the Tikal lintel (Fig. 2) I confess that I feel a little less compromising. According to Dr. Forbes the central part of this design is a "specialised" (sic !) "argonaut or octopus" with beak and two glaring eyes, etc. I can only say that, if this is a true interpretation, then the artist has thrown the structure of his model to the winds and relied on the most generalised conception. This is no doubt very often done in highly conventionalised art, but the admission weakens any interpretation that relies on the data of realism, as Dr. Forbes does. The "superciliary ridge" from under which the eyes glare out is, according to Dr. Forbes, "the fleshy upper margin of the mollusc's mouth." In other words, the eyes and mandibles of the supposed Octopus, which are in the living animal on opposite sides of the umbrellar membrane, are not only on the same side of the latter in the Tikal lintel but the eyes are also actually placed inside the labial membrane! The structures assumed by Dr. Forbes to be sucker-bearing arms may conceivably constitute a *motif* based on these structures; but the round circles (*sc.* suckers) turn up in this design in places where it is difficult to assign them to any particular arm, so that they may be merely decorative symbols devoid of any natural basis.

While allowing a vague suggestion of a cephalopod *motif* in Fig. 2, I consider such an interpretation quite devoid of basis in Fig. 3, while in the case of the Copan Stela it is not possible to offer any serious comments, as the photographs are not good enough to enable one to form an opinion. Fig. 5 may suggest a squid, though its apical extremity is curved suspiciously like

an elephant's trunk; while one would have thought that alongside the "trunk" in Figs. 5 and 6 there were represented (in a conventionalised fashion) structures that look like tusks.

In conclusion, I should like to say that Dr. Forbes has certainly rendered a service in giving alternative explanations to some of the *motifs* of primitive American art. I do not agree that any of the figures (except possibly that of the Manabi slab) reveal a *whole* cephalopod, though parts of his Figs. 2 and 7 suggest that the arms may have been employed as incidents in larger designs. I feel, however, that unless we can obtain evidence as to the earlier stages from which this very conventionalised and, I venture to suggest, somewhat debased method of design was evolved, a Proboscidean, a Molluscan, or even a Cœlenterate interpretation will be equally plausible.

G. C. ROBSON.

British Museum (Natural History),
August 19.

On the Mercury Line λ2270 A.

IT is a remarkable fact that of the three transitions of an electron in a mercury atom represented by $1S-2p_1$, $1S-2p_2$ and $1S-2p_3$, we see optically only $1S-2p_2$ (λ2536), while the other two, namely, $1S-2p_1$ (λ2270) and $1S-2p_3$ (λ2655), have not been observed at all except by the indirect method of measuring the ionisation by impacts of electrons on atoms by Franck and Einsporn (*Zeit. f. Physik*, ii. p. 18, 1920).

In 1922, at the suggestion of Prof. N. Bohr, one of us, in conjunction with Prof. H. M. Hansen and Dr. S. Werner (Kgl. Danske Videnskab. Selskab. Math.-fys. Medd. v. 3, 1923), tried to find how to make possible the transitions from these two meta-stable states $2p_1$ and $2p_3$ to the normal state $1S$.

As a result, we found that the line λ2270 is excited in a Geissler tube when a condensed discharge is passed, whereas the line λ2655 was not detected at all.

In the present experiment, the account of which will be published later in detail, we tried to get the line λ2270, not in the spark spectrum but in the arc spectrum of mercury.

We found that the arrangement used by Messrs. Metcalfe and Venkatesachar (Proc. Roy. Soc. A, 100, p. 149, 1921; A, 105, p. 520, 1924) for the study of the absorption of mercury lines produces the line λ2270 with considerable intensity. Instead of using the long tube filled with mercury vapour as the source of absorption, we employed it for emission, and by passing a current from 2 to 3 amperes through the long tube, which we might call "a branched arc," we found that the intensity of the line λ2270 could be raised so as to come between $m=8$ and $m=9$ in the diffuse series $\nu=2p_2-md_2$. In other words, the line λ2270 appears stronger than λ2303 ($m=9$), but fainter than λ2323 ($m=8$).

Using the largest size of quartz spectrograph made by Hilger (Littrow type), and photographing in juxtaposition the line λ2270, first as excited in the above method, and second as excited in a condensed discharge, we found that the latter method of excitation gives a shift of about 0·1 A to the red side, with a faint companion line on the red side at a distance of about 0·2 A.

Similar shifts were observed for the line λ2345 ($\nu=2p_3-5s$) in the same sense, but in the opposite sense for the line λ2564 ($\nu=2p_2-4S$). The shifts are not due to the manner of projecting the image on the slit, since there are many lines which show perfect coincidence; neither does it seem likely that the shifts are due to the Doppler effect, as they remain the same when we change the polarity of the condensed discharge, which was fairly well rectified.

No trace of the line λ2655 ($\nu=1S-2p_3$) was observed.

T. TAKAMINE.
M. FUKUDA.

The Institute of Physical and
Chemical Research, Tokyo.

A Rotational "Fatigue" Effect of the Electric Discharge.

IN some recent experiments on the volt-ampere characteristics of low-tension discharge tubes, I utilised an "Osglim" lamp of the "beehive" variety, sealing it on to an apparatus so that air at different pressures could be introduced. (The lamp consists of an iron disc anode and a spiral cathode of thick iron wire, wound above the anode.)

It was observable at certain pressures that, when the discharge was continuous, but failed to cover completely the cathode, the discharge shifted from one part to the other of the cathode surface, often undergoing a regular cycle. At other times the motion was along the wire of the spiral, slowly backwards and forwards through a rotation of up to 120°, and even more. The rotation continued over long periods of time in a most interesting manner.

The phenomenon is apparently an electrode "fatigue" effect. When one portion of the surface has been serving as cathode for some time, it becomes "fatigued," and the value of the cathode fall of potential rises; it then becomes easier for the discharge to pass over at an adjacent portion of the cathode, and consequently the discharge rotates slowly.

That the rotation is accompanied by a corresponding fluctuation of the voltage drop across the tube is evident from the fact that the reading of the voltmeter, across the tube, rises and falls at a similar rate (there is of course a lag), and to a lesser degree variation of the current is observable.

JAMES TAYLOR.

Armstrong College, Newcastle-upon-Tyne,
August 19, 1924.

Zoological Nomenclature: Generic Names for the Official List.

THE following generic names (with genotype in parentheses) have been submitted to the International Commission on Zoological Nomenclature for inclusion in the official list of generic names.

The Secretary will delay final announcement of the votes on these names until January 1, 1925, in order to give to any zoologists, who may desire, the opportunity to express their opinions.

Amphibia: *Cryptobranchus* Leuck., 1821, 259 (*gigantea=alleganiensis=alleghaniensis*); *Desmognathus* Baird, 1849, 282 (*fuscus*); *Siren* Linn., 1766, addenda (*lacertina*).

Reptilia: *Alligator* Cuv., 1807, 25 (*mississipiensis*); *Calamaria* Boie, 1827, 236 (*calamaria*); *Chelydra* Schweigg., 1812, 292 (*serpentina*); *Crotalus* Linn., 1758a, 214 (*horridus*); *Dermochelys* Blainv., 1816, 119 (*coriacea*); *Eremias* Wieg., 1834, 9 (*velox*); *Lacerta* Linn., 1758a, 200 (*agilis*); *Mabuya* Fitz., 1826, 23 (*sloanii*); *Phrynosoma* Wieg., 1828, 367 (*orbiculare*).

Pisces: *Blennius* Linn., 1758a, 256 (*ocellaris*); *Echeneis* Linn., 1758a, 260 (*naucrates*); *Esox* Linn., 1758a, 313 (*lucius*); *Ophidion* Linn., 1758a, 259 (*barbatum*).

C. W. STILES,
Secretary to the International Commission on Zoological Nomenclature.

Hygienic Laboratory, Washington, D.C.

Chemistry and the State.[1]

By Sir ROBERT ROBERTSON, K.B.E., F.R.S.

THE appeal of the State to chemistry has developed through the gradual recognition of the need for the application of that science to matters relating to its preservation, its currency, its financial support, its health, its food supply, its industries, and finally to academic science. In the course of this development in Great Britain, advantage has been taken, if sometimes tardily, of the general advance in chemical knowledge, and frequent recourse has been had to the advice of well-known chemists of the day, and collectively of the Royal Society; thus for various purposes the following chemists, as officials or consultants, have in the past afforded assistance in the solution of specific problems referred to them, or by taking part in Commissions: Boyle, Newton, Davy, Faraday, Daniell, Graham, Hofmann, Redwood, Abel, Roberts-Austen, Percy, Dupré, Playfair, Frankland, Ramsay, and Dewar. It has happened in several instances that as a result of these Commissions and references to chemists, some definite chemical activity of the State has emerged.

The following summary reviews the State's chemical activities before, during, and after the War.

BEFORE THE WAR.

Defence.—For the defence of the State, establishments for the production of explosives were early maintained, and when this ultimately took the form of a chemical manufacture, the Government factory took the lead in devising efficient processes, while from the various State research establishments has issued during the last fifty years an important body of original contributions to the theory of explosives and to the knowledge of their properties.

Metallurgy.—The metallurgical progress of the country has always been a concern of the State by reason of its application to defence by land and sea, and close touch has been maintained with successive developments in the manufacture and use of cast iron, wrought iron, steel, and non-ferrous alloys. While the main advances in process have been made in the great iron and steel works, material contributions to knowledge in this sphere have been made by chemists in the Government service.

Revenue.—For the revenue of the State, imposts were applied in early times, but with great uncertainty, until the charge was put on a scientific basis. Very accurate tables for the strength of alcohol were worked out under the supervision of the Royal Society at the end of the eighteenth century, to be superseded by revised ones issued only a few years ago, when, in addition, new tables were issued also by the Government Laboratory, for determining the gravity of worts before fermentation. The question of rendering alcohol unpotable, but still useful for industrial purposes, has occupied much attention. It was on account of the necessity for safeguarding the revenue that the Government Laboratory was primarily erected, although it now performs chemical work for all State Departments of Great Britain.

Health.—The three main steps with regard to public health and sanitation in this period were the forcing of these questions into prominence by Playfair, with the consequent Commissions and legislation leading to the formation of the Local Government Board and its successor, the Ministry of Health, which has many varied activities in preserving purity of air and water and protecting the workman in dangerous trades; secondly, the determination of standards for a safe water supply by the pioneering work of Frankland; and, thirdly, the appointment of public analysts by the local authorities, with the Government Laboratory as referee, for safeguarding the supply of food.

Agriculture.—Science was being applied to agriculture about the end of the eighteenth century, and at the beginning of the next, Davy did pioneering chemical work for the Board of Agriculture. Private endeavour is responsible for the next development, State action being limited to the prevention of fraud in the sale of fertilisers and feeding-stuffs. In 1909, however, the annual allocation of a sum of money to the Development Commission for the advancement of agriculture stimulated research in a large number of institutions engaged in the scientific study of problems in which chemistry plays an important part.

Other Activities.—In addition to the chemical work referred to above, there is a variety of subjects connected with State Departments to which chemists have contributed, such as the composition of the sea, and the composition and physical chemistry of rocks and building-stone. At the Government Laboratory a large number of investigations have been conducted on matters directly referred from Government Departments.

DURING THE WAR.

In all the activities described, the War requisitioned the work of the chemist, but, naturally, predominantly to meet the demands of active warfare.

Defence.—The attention that had been bestowed on the subject of propellants enabled expansion to take place with no important alteration in the technique of their manufacture, to which was adapted a new type of cordite, ultimately made on the largest scale, without using an imported solvent. For high explosives Great Britain was in much worse case, as these had not been made by Government, and were manufactured only in small quantity. Their study at Woolwich led to a rapid evolution of new processes, substances, and methods of use. Thus a method was worked out for the manufacture of trinitrotoluene, and to save this substance a new high explosive, amatol, was devised. This explosive, consisting of ammonium nitrate and trinitrotoluene, passed exhaustive trials and was ultimately produced at the rate of 4000 tons a week. The production of the ammonium nitrate for the mixture was in itself a stupendous undertaking, and the methods of filling the explosive into shell and other munitions gave rise to much ingenuity. In the Research Department, Woolwich, the number of qualified chemists engaged

[1] From the presidential address to Section B (Chemistry) of the British Association, delivered at Toronto on August 7.

in the study of explosives in all their aspects ultimately exceeded a hundred, while for manufacture and inspection more than a thousand were employed. The ideal set before himself by Lord Moulton in 1914, to produce nothing less than the maximum of explosives of which Great Britain was capable, was realised, and they assumed a quality and character that caused them to be copied by our Allies, and proved themselves more trustworthy than those of the enemy.

Starting unprepared, and without the advantage of a well-developed fine chemical industry, Great Britain was able ultimately to make a reply in the field of chemical warfare that was rapidly becoming more and more effective; at the same time, by study and often self-sacrificing experiment, protecting the soldier by the development of very efficient respirators. In this connexion and in that of explosives, nearly every professor of chemistry in the country, and many from beyond the sea, were engaged.

Metallurgy.—The enormous demand for metals for munitions and countless other war requirements led to an unprecedented concentration of the metallurgical industries on the needs of the State, and to an equal concentration of metallurgical science on investigation devoted to improvement in quality of materials for new and special war purposes. The work of the Aircraft Production Department, aided by many metallurgists and engineers, on alloy steels; of the National Physical Laboratory on aluminium alloys; and of the Metallurgical Branch of the Research Department, Woolwich, on the heat-treatment of heavy forgings and on the drawing of brass, is typical of the successful effort made in every quarter. The knowledge thus gained was disseminated in the form of specifications, instructions, and reports, and has had a great and permanent effect on manufacture.

Health.—A committee of the Royal Society had been studying food values, and was able to afford the Food Controller, when he took office, valuable data bearing on the rationing of food. The committee had dealt with subjects which shortly became of much importance, such as a better recovery of flour in milling wheat. The chemical examination of the food for the Army during the War, carried out by the Government Laboratory, employed a large staff of chemists. For the supply of many fine chemical substitutes used in medicine and surgery, formerly imported from abroad, such provisional arrangements had to be made as the organisation of a large number of university laboratories on a semi-manufacturing basis.

Agriculture.—Effects on agriculture during the War were shortage of the usual feeding-stuffs for cattle and of fertilisers. The chemists stationed at Rothamsted gave special attention to the shortage of manures and prepared instructions for the guidance of farmers; and several sources of supply of potash were exploited, including kelp, felspar, and the flue-dust of furnaces. As sulphuric acid was required for explosive work, fine grinding of phosphates and basic slag was adopted and found to be more efficient than was expected. Shortage also directed the attention of chemists to the use of little known food-stuffs, especially for cattle, and the information gained as to their feeding value was important.

Other Activities.—In many other activities in connexion with the War, chemists were directly involved, such as in affording advice on the conservation of materials, on the numerous questions arising from the operations of the War Trade Department, on the restriction of imports and exports, and on matters of contraband.

After the War.

The magnitude of the chemical effort, it can be claimed, was a factor in winning the War which must be reckoned as of importance only second to that of the bravery of our forces in the field. But it has left a lasting mark, and given to chemistry a value which, were it not for the rapidity with which the achievements of science are forgotten, ought to keep before the public its connexion with almost every phase of activity.

Defence.—To take our subjects in the same order, we may consider some of the effects of the energy spent on the production of munitions. The intensive study of explosives and of other chemical substances used in the War has led to a more complete knowledge of their chemistry, their physical and explosive properties, and has advanced chemical theory. These advantages are not of military importance only, but are reflected also in the production of trade explosives. The collected records of the Department of Explosives Supply afford examples of treatment of many problems of interest to the general chemical technologist, and not only to the explosives expert.

A further benefit was reaped by chemists in every position, from the professor to the youngest graduate, coming into direct contact with manufacturing methods and thus gaining insight into the applications of their science. While it is true that the opportunity came to few of these to take part in the design of plant and primary choice of process, nevertheless the experience was a novel one, as it led them into the field of technology, and cannot fail to have widened their outlook. It became apparent that there was a shortage of a type of chemist which had been developed in Germany, skilled in the transference of the chemical process from the laboratory to the works scale in the largest enterprises. A chemist of this type is one who, besides having a sound knowledge of chemistry and physics, has had experience in the materials of construction used on the large scale, and in the operation of the usual types of plant for carrying out the operations of chemical manufacture, and is capable of working out flow-sheets illustrating the process, and operating plant with every regard to economy. The need for instruction in such subjects had been borne in on men like the late Lord Moulton, and as a direct result of the war-time experience of our deficiencies in this direction has arisen the movement for creating chairs of chemical engineering in some of our universities. It is to be expected that from these schools, especially where the instruction is superimposed upon a full graduate course, will come men who will lead the way in the application of academic science to industry.

Metallurgy.—While the interest of metallurgical science in war material has fortunately fallen to a peace-time level, State participation in the support of scientific research remains far greater than before the

War. In metallurgy it is exercised through the Department of Scientific and Industrial Research, with its organisations of the National Physical Laboratory and the Industrial Research Associations, as, for example, those dealing with the non-ferrous metals and with cast-iron. The State also continues to maintain efficient research departments for the Fighting Services, but it is significant that the largest of these is undertaking industrial metallurgical research on a considerable scale, for the benefit of the brass and other industries. State support and encouragement are undoubtedly powerful factors in the rapid progress now taking place in every branch of metallurgical science in Great Britain, and there is scarcely any related industry which can fail to benefit.

Revenue.—Since the War the principal matters affecting the revenue are the higher duties, which have rendered necessary a further denaturation of alcohol. Improved facilities have been granted for the use of alcohol for scientific purposes and in industry; regulations have been formulated for the use of power alcohol, and duties have been established on imported fine chemicals and synthetic dyestuffs.

Health.—The food shortage during the War directed attention to the nature and quantity of our food supplies, and led to further investigations being undertaken by the Department of Scientific and Industrial Research on food preservation and storage. Activity is also shown by the appointment of committees which are working on the subject of preservatives and colouring matter in food, and on the pollution of rivers by sewage and trade effluents. A great field is open in the co-operation of chemistry with medicine in the discovery of substances suitable for the treatment of the numerous diseases now traced to parasites in the blood.

Agriculture.—So far as fertilisers are concerned, the lack of a supply of fixed nitrogen from the air which obtained throughout the War has now been rectified, and Great Britain for the first time is no longer exceptional among the nations by neglecting to provide itself with synthetic ammonia for agriculture and for munitions. Such war-time expedients as the use of nitre-cake instead of sulphuric acid for making ammonium sulphate and superphosphate, and the recovery of potash from flue-dust, have not survived, but there has been a gain in the further development of "synthetic farmyard manure" and the increased use of basic slag. The present activity in research in agricultural chemistry of a fundamental character is leading to a better understanding of problems of the soil and of plant and animal nutrition, and cannot fail to be of ultimate benefit to farming.

Organised Applied Research and Assisted General Research.—Established during the War as a result of an appreciation of the contrast between the successful application of scientific method to military purposes and the want of such application to many of our manufactures, the Department of Scientific and Industrial Research has extended over a wide field. Its main activities are in the directions of State encouragement to industry to apply chemistry to its problems, of State investigation of vital problems beyond the sphere of private enterprise, and of assistance to workers in the purely academic field. In all these spheres activity is shown by the contributions to knowledge already forthcoming.

Personnel.

In the expansion that has occurred in the chemical sections of State Departments since the War, it is interesting to note the increase in the number of chemists that are employed. So far as can be gathered, the number of chemists working in departments maintained wholly by the State is 375 for the present year, compared with 150 in 1912, while in establishments to which the State affords partial support, such as those under the Development Commission and the Research Associations, the corresponding numbers are 150 and 50. In addition, grants are made to 145 research students and to 11 independent research workers, involving a yearly sum of about 50,000*l.*

Development of Chemistry in the Modern State.

From the foregoing account of the connexion of the Departments of State in the United Kingdom with chemistry, it is possible to trace a gradual development and ultimately a change in attitude, in passing through the stages of compulsion, expediency, and assistance.

From motives of security the State was compelled to give heed to chemical matters involved in its defence, such as those which appertained to munitions of war, including metals used in their manufacture; it was constrained to uphold the standard of its currency; and it was obliged to secure a revenue. As a consequence, the first chemical departments were set up in connexion with these activities, and from them have emanated notable additions to chemical knowledge, improvements in methods of manufacture, and specifications for Government requirements that have led to improved material becoming available for civilian use. Although mostly conducted with inadequate staff, the study of these questions, it can be claimed, proved of national advantage when the time of need arose.

In the next stage, the public conscience having been awakened by the pioneering work of Playfair, it appeared expedient to safeguard health by attention to sanitation, and, as the quality of food was unsatisfactory, to set up a chemical control. Although a start was made by Davy, a member of the Board of Agriculture of the day, progress in this subject passed to private enterprise, and a century elapsed before direct assistance was afforded to this important matter. Out of these activities come our present system of supervision over the purity of air, water and food, and also the recent progress made in the application of chemistry and physics to problems of the soil.

The last and more recent stage is in the nature of a recognition that the State is under an obligation to assist science, and in this case the science of chemistry, on which so many important industries are based. The War brought home the danger that, although the record of Great Britain as regards discovery in pure science was unrivalled, its systematic application was too often left to other countries, with the result of lamentable shortages during the War and the risk of many industries being ineffective in peace. A measure of government intervention and action appeared

requisite, and research became the business of a government department. Outside of the great firms which maintain progressive chemical staffs, the firms in numerous industries have been encouraged and assisted to co-operate in the betterment of their manufactures by the application of the methods of science, and from these associations and the organisations dealing with national problems begins to flow a stream of communications indicative of useful work accomplished. Nor is the foundation of it all neglected, for encouragement is given to workers in the academic field to follow out their ideas, whithersoever they may lead them, in accordance with the truth that "research in applied science might lead to reforms, but research in pure science leads to revolutions."

It is important to be able to record an advance in securing an interchange of information among government departments, and between their work and that of the universities, a matter which before the War was unsatisfactory, as it was mainly personal and sporadic. It is also a hopeful sign that, although the knowledge and appreciation of the methods and capabilities of science are still generally wanting, there have been signs of late years that these matters are coming to engage the attention of those who guide the policy of the State.

Centenary of the Franklin Institute.

ON March 30, 1824, the Governor of the State of Pennsylvania signed an Act incorporating the Franklin Institute for the Promotion of the Mechanic Arts. The centenary of its foundation will be observed in Philadelphia on September 17, 18, and 19, by celebrations reminiscent of the rise, growth, and continuity of purpose of a remarkable institution, now, after many inevitable vicissitudes, rooted deeply in the national life of the United States, at the same time commanding the allegiance of men of science in most other countries. Accordingly, delegates representing several of the universities of Great Britain, as well as scientific societies, will join those from Canada, France, Holland, and Germany in united expression of congratulation. To have wrested "secrets of excellent use" from Nature marks and cements the common bond.

When we direct our minds back to the Institute's initial year, 1824, it serves us to recall that here, in England, we had Sir Humphry Davy—at the height of his fame—installed as president of the Royal Society, whilst round about that period many special scientific organisations were springing into being. Among such were the Horticultural Society (1804), Geological Society (1807), Institution of Civil Engineers (1818), the Royal Geographical Society (1830) and the British Association (1831).

The Franklin Institute was established to meet the need for an institution similar to that founded in London in 1799 (the Royal Institution) by Benjamin Thompson, Count Rumford. The founders had before them, also, the history and objects of the Anderson College of Glasgow, where Dr. George Birkbeck had lectured on mechanics and applied science with inspiring zeal and successful issue. The initial tentative effort was due to two Philadelphians, Samuel V. Merrick and William H. Keating, the latter then chosen by the University of Pennsylvania to occupy a new Chair of Chemistry in its Application to Agriculture and the Mechanic Arts. They discussed a project—one of them, by the way, had been told he was wasting his time—but they were bent upon going forward. They called in two others as colleagues, and the four—all young men—using the Philadelphia Directory, selected from it the names of some 1500 citizens, inviting them by circular letter to attend a meeting on the evening of February 5, 1824, to discover and talk over plans. The meeting was a success, not a little to the surprise of its conveners, approbation of the purpose in view, namely, that of assisting the knowledge of physical science and its diffusion in the arts and sciences, being expressed freely. Later, an election of officers took place, and the promoters chose a name for their offspring. Certainly none could have been more fitting than that of "Franklin Institute," both for immediate testimony and posterity's keeping. There seems to have been no dissension. The glamour of the great "printer-philosopher" was with them in the city where he had worked, and hence homage was rendered. The original scheme prospering, in twelve months' time the corner-stone of a marble-fronted building, destined as a home, was laid (we are told "in ancient and Masonic form by the Grand Lodge of Philadelphia, in the presence of the Society") on June 8, 1825, and completed in 1826. Upon the first floor (to-day) are located the lecture room, laboratories, and offices. The second floor is occupied by the library, whilst the third is devoted to the Museum of Models and Historical Apparatus.

Membership of the Institute is open to men and women, without regard to distinction of race, nationality, or religion, the only requirements for admission being good character and interest in its work. The artisan and the professor meet within its walls upon an equal footing, and it is to this happy blending of "Science with Practice" that the particular usefulness, past and present, of the Institute must be ascribed. General meetings are held once each month, except during the summer. At these, inventions and discoveries, important engineering projects and notable achievements in all fields of scientific progress, are presented, exhibited, or discussed. Many epoch-making inventions have been shown in their experimental stages at these meetings—for example, the phonograph, electric arc, the typewriter, liquid air apparatus, and telegraphy improvement devices. The average membership for the period 1912–1922 was 1380, and in view of the greater interest now manifested in the Institute's work, special efforts are to be made towards an enlargement of its roll.

Three permanent features of the Institute's activities are the maintenance of a reference library, the holding of exhibitions, and the publication of a Journal for the diffusion of knowledge on all subjects connected with science and the useful arts. All three formed part of the original plan of the founders, and the efflux of time has added materially to their importance. We gather from a recent report referring to the library that it is,

of its class, second to none in the United States, embracing the publications of the principal scientific and technical societies of the world. An extensive collection of patent literature has been brought together indispensable to inventors and manufacturers. It is worthy of mention that in 1922 the library received a unique and valuable collection of books and pamphlets on windmills, inclusive of treatises on the subject printed in German and Dutch in the seventeenth and eighteenth centuries, and a book of 400 views of windmills in all parts of the world. As a means of fostering the mechanic arts, the holding of exhibitions was very early encouraged, and for many years kept in view. A notable one was the Electrical Exhibition of 1884, held under the direction of the Institute and by Act of Congress made international in character.

The Journal of the Institute in its present form is an octavo of about 150 pages, published monthly, and it consists in large part of reports of lectures delivered before the Institute and its sections, together with selected original communications from specialists. Mention may be made of a paper by Dr. F. W. Aston, on "Atomic Weights and Isotopes," being a summary of a series of lectures delivered before the Institute in 1922. A series of lectures was also given in 1923 by Sir J. J. Thomson, on "The Electron in Chemistry." Here it is convenient to record that the Institute now publishes annually a "Year Book," which we may say is one of the most concise and distinctive issues of the kind that we have seen.

Various honorary awards of medals and premiums are made by the Institute, some of which are of old standing, and highly valued, such as, for example, the Elliott-Cresson, Potts, and Longstreth medals. The most recent foundation is the Franklin gold medal (with diploma), instituted in 1914, and allotted annually to those workers in physical science or technology, without regard to country, whose efforts, in the view of the Institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science and its applications. The latest recipient of this gift was Sir Ernest Rutherford.

Under new rules, adapted to modern requirements, the Institute conducts investigations, through its Committee on Science and the Arts, on the soundness and practicability of inventions, discoveries, and improvements in physical processes or devices, submitted to it. During the past twenty-five years nearly 1000 applications have received adjudication.

In 1921 the Institute received a bequest from Henry W. Bartol, a life member, of 1,208,468 dollars for research. Agreeably therewith a "Bartol Research Foundation" was established for the purpose of conducting researches relating to fundamental problems in physical science, particularly those in the field of electricity, and for the investigation of specific problems of a scientific nature which may arise in the industries. An arrangement was made to build a laboratory wherein to engage in these objects, but unfortunately up to the present nothing has reached fulfilment, owing to the high cost of building construction. It is a trust which we may be sure will eventually become operative.

The principal events of the Centenary programme comprise, on the first day, an assembly at the Franklin Institute, and an academic procession to the Walnut Street Theatre, where the Mayor of Philadelphia will deliver an address of welcome, and addresses will be given by Dr. W. C. L. Eglin, president of the Institute, and Prof. Elihu Thomson, honorary chairman of the Centenary Celebration Committee. On September 18 the chief fixture is a lecture on "The Natural and Artificial Disintegration of Elements," by Sir Ernest Rutherford. The morning of September 19 will be taken up by the unveiling of a tablet in connexion with the Bartol Research Foundation. Addresses will afterwards be given by Dr. Arthur D. Little, of Cambridge, Mass., on "The Fifth Estate," and by Prof. Jacobus, advisory engineer, the Babcock and Wilcox Co., New York City, on "Stimulation of Research and Invention." Garden parties, and fraternal hospitality in the shape of banquets to the delegates and guests, have all been provided for in unstinted fashion. A list of speakers at the sectional meetings has been drawn up. These include Sir Charles Parsons, Sir William Bragg, Prof. E. G. Coker, Prof. A. A. Michelson, Prof. Zeeman, and Prof. F. Haber.

NATURE proffers its heartiest congratulations to the Franklin Institute on the occasion of the Centenary, and its earnest hopes for future development and prosperity. T. E. J.

Current Topics and Events.

THE three hundredth anniversary of the publication of Francis Bacon's famous "De Dignitate et Augmentis Scientiarum" was fittingly celebrated at the seventy-eighth meeting of the American Association for the Advancement of Science at Cincinnati by a symposium of five papers, which have recently appeared in *Science*. Special interest attaches to the first of these by Prof. Mark H. Liddell, of Purdue University, outlining Bacon's scheme for a College of Research. His plea for the proper organisation of research is preceded by an attack on the neglect of science in the university of his day. "If any man thinks pure science an idle pursuit he fails to realise that from thence is all applied science supplied." Bacon accuses the college professor of his day of lacking in virility, and attributes this in part to the smallness and meanness of his emoluments. He also accuses the universities of their failure to produce facilities for research "in the way of laboratories, botanical gardens and other instrumentalities of investigation," and insists that "research is the intelligence department of organised knowledge," and hence must be properly financed. So Bacon comes to his own programme for the regeneration of learning by research, along two broad lines: one to provide the scientific method for the *magna instauratio*, the other the material and personnel to make it effective. The former of these he achieved in 1620 with the publication of the "Novum Organum." The second object, the provision of the College of Research (Bacon called it a College of Inventors), was never realised, but his own memorandum,

originally drafted in 1608, clearly outlines his intentions. Bacon contemplated a building equipped with libraries, laboratories, furnaces, vaults, and workshops, together with a hall of fame for statues of the great men of science, past, present, and future. There were to be rules for the conduct of studies and research, and money allowances for travelling expenses and for apparatus. There was also included a scheme for the recording of results in cipher until the time for publication was deemed appropriate. Finally, the scheme provided not only for the due rewarding of valuable research, but also for the removal of members whose work was fruitless.

ORNITHOLOGISTS have recently been hearing a good deal of the International Museum of Comparative Oology at Santa Barbara, California. We have now before us the first number of the Journal of this Museum, edited by the director, W. L. Dawson, and entitled *The Comparative Oologist*. Throughout, the claim is made that oology is an independent science of considerable importance—once indeed we are told that "Oology is the science of one half of the biologic process"; but the Journal itself enables us to see how much weight is to be attached to these claims. We will content ourselves with one passage, in which the editor informs us that the shell of a bird's egg has been formed in the ovary, "that innermost sanctuary of life"! and therefore enables us (how is not stated) to penetrate into the mysteries of "the reproductive stream itself." Numerous other quotations could be made to show that Mr. Dawson, while admirably qualified to write of generalities in a high-faluting style, appears to be unfamiliar with elementary facts concerning his special subject-matter. We wonder what men like Dr. R. Ridgway, Dr. Shufeldt, Mr. Oberholsen, or the Rev. F. Jourdain will feel when they see themselves associated with the highly original avian anatomy and physiology of the sort we have quoted. We may also quote from the rules: "Any person of scientific integrity, having attained the age of 18, who is interested in the pursuit of oology as a science *or in the collecting of birds' eggs* (italics ours) may become a 'Scientific Member' of the Museum." That is what many had supposed: now we know it. But the Museum cannot have it both ways. It can be a centre for egg-collectors, patrons of what is an amusing and interesting sport if not carried (as unfortunately sometimes happens) to the pitch of mania. Or it can be an institution for the scientific study of egg-shells, from which we may doubtless expect some, though not very much or very valuable, new knowledge. But it must not think that it can use science as a cloak for mere collecting; and that is precisely what, with its present rules and organisation, it appears to be trying to do.

THE subject of chemical apparatus and plant production generally received special consideration in the recent address of the retiring chairman (Mr. L. M. G. Fraser) of the Chemical Plant Manufacturers' Association. The improvements in the construction of plant have been along well-defined lines, the aim being to produce a better article at a lower working cost and with greater safety. Examples were given indicating lines of progress, and reference was made to (1) the more economic output of grinding machines, (2) the simplification of emulsion formation, (3) the increased usefulness of filter plant and the development of the stream line filter, (4) the distillation of special liquids with less risk and greater economy and the more efficient fractionation in still columns, (5) improved mechanical crystallisers and mixers, (6) the more thorough understanding of furnaces, and (7) the control of temperature. The better utilisation of metals and alloys and the more intimate knowledge of the action of heat on substance are regarded as factors which have helped progress. The separation of ashes from coke and unburnt coal by means of electromagnetic separators is now being carried out on a commercial scale. Recent developments in electrolytic cells were also noted, and the need for further investigation on the electrolysis of certain inorganic substances indicated. Mr. Fraser is hopeful that, with experience from similar work in other directions, plant could be properly designed to meet new needs. Many general questions bearing on plant construction were touched upon, such as the power factor in the movement of bulk materials, the study of the thermal efficiency of fuels and the interchange of heat, the general freedom from breakdown of machinery and the automatic control of operation. Improvements so far achieved have enabled many difficulties to be overcome, and future plans can be laid with greater confidence.

TWO series of coloured postcards have recently been issued by the British Museum (Natural History), one depicting the migrant bird visitors of spring, the other those of winter. A separate card is devoted to each species, and in many instances, to an excellent "close-up" view of the bird in its normal surroundings, there is added a more distant view which indicates with great success the features that catch the eye "in the field." The colouring is very faithful to life, and the artistic effect of each card delightful. Each series is offered in sets of five cards for 1*s*., the cards being numbered in the order in which the birds usually arrive in Great Britain. Thus the first set in the spring series contains wheatear, ring-ouzel, chiffchaff, sand martin, and swallow; and that in the winter series, snow-bunting, redwing, brambling, fieldfare, and hooded crow. Accompanying each set is a printed leaflet in which the breeding and migration habits of each species are set out. In addition to giving much pleasure to all bird-lovers, these cards should prove of great value to teachers in supplementing lessons in Nature study, especially in urban schools and in those which have not the good fortune to possess a natural history museum.

THE number of new periodicals dealing with various aspects of natural science which have been started in Japan in the last few years, is clear evidence of the attention now being given in that country to the investigation of its own natural resources; for most of the journals contain papers dealing with products occurring in Japan or which are being imported into

Japan for use. One of the most interesting of these journals is *Acta phyto-chimica*, now in its second year, which is published by the Iwata Institute of Plant Biochemistry at Tokyo, and edited by Prof. Shibata. In it have been published already a number of important papers, including those of Asahina and Fujita on anemonin, and a detailed résumé by Asahina on his work on *Evodia rutæcarpa*, which has resulted in the isolation of two new alkaloids, evodiamine and rutæcarpine. The structures of these bases have been determined, and shown to be related to those of harmine and harmaline, familiar to British chemists through the work of Perkin and Robinson. No less interesting is the series of papers by Shibata and his collaborators on natural flavone colouring matters. In the current number of the journal (volume ii. No. 1), Prof. Asahina and several of his students have an important paper on the ketone of the essential oil of *Elsholtzia cristata*, Willd., which is shown to be a furan derivative, and is only the second substance of this type thus far found among the thousands of known components of essential oils, the other being Semmler's carlina oxide.

A REPORT of the administration of the Meteorological Department of the Government of India in 1923–24, by Sir Gilbert T. Walker, Director-General of Observatories, now retired, has recently been issued. Reference is made to retrenchment of expenditure and to its interference with effective weather warning. The main curtailment of expenditure was effected in telegraphic charges. The issue of the Calcutta, Bombay, and Madras reports was restricted to periods of 10½, 6, and 9 months respectively, and the number of stations reporting was greatly curtailed. Four cyclonic storms were formed in the Bay and one in the Arabian Sea. In May, a severe cyclone was experienced in the Bay, in which the S.S. *Okara* was lost. The loss of this vessel has led to certain changes in the method of broadcasting important weather information, more frequent weather warnings being issued. In connexion with the upper air work, which centres round the Agra Observatory, out of 36 "instrument balloons" sent off during the year, there were 21 recovered. Pilot balloon work was started at Bombay and Peshawar. An extension of meteorograph flights is contemplated so as to obtain observations to heights of 12 miles or more, and to participate in the important work undertaken in other countries. Radio weather messages are received from ships and greatly supplement the coast observations in the warning of cyclones. For the "Rainfall of India," observations are received from nearly 4000 stations. Seismological observations are recorded at several places in India and are forwarded to the Seismological Committee of the British Association.

THE *Marine Observer* for September, published by the Meteorological Office of the Air Ministry, has recently been received. It is prepared under the supervision of Captain L. A. Brooke Smith, the Marine Superintendent. The publication is essentially a vehicle for supplying to seamen valuable meteorological data of interest for voyages in all navigable seas; numerous incidents are given from the meteorological logs kept for the Office, and mariners are invited to contribute information of interest if not regular observers. The current number contains an article on "The Origin of Tropical Revolving Storms" by Capt. D. Brunt, Superintendent of the Army Meteorological Services. A large amount of wireless weather information is given, a special chapter in the issue for each month dealing with a different branch of meteorological information; the September number deals with "wind and set and drift of current." Specimen charts show currents and winds experienced in home waters, cyclone tracks are given for various oceans, a map shows recent ice in the North Atlantic, and notices are given of recent derelicts and floating wreckage. The August number contained a discussion on the "Hong Kong Typhoon, Aug. 18, 1923," by Commander J. Hennessy, the Nautical Senior Professional Assistant; also an article on fog by Mr. H. Keeton. A list of contents would be a useful addition to future issues.

THE first conference of Special Libraries and Information Bureaux was held on September 5-8 at High Leigh, Hoddesdon, Herts. The objects of the conference were outlined at the opening session by Dr. R. S. Hutton, director of the Non-Ferrous Metals Research Association, and Mr. J. G. Pearce, director of the Cast Iron Research Association. It has long been felt that many diverse agencies concerned with the treatment of information have problems in common, and need an opportunity to establish mutual co-operation and assistance, and to determine their relationship to the press, and to the great municipal and national libraries and other institutions. The conference, which was highly successful, provided abundant evidence of the interest in this field of work, and in order to ensure continuity of interest, without forming another association, a standing committee of the conference was appointed with power to consider matters in the interests of those engaged in directing or operating Special Libraries, and to convene a further conference at some future date. This committee is representative of a wide range of institutions, and has already held its first meeting. The most striking feature of the conference was the keenness displayed by a large number of highly diversified interests, including scientific, technical, industrial, wholesale and retail commerce, railways, political, agricultural, governmental, universities, press, medical, sociological and banking. This diversity served to emphasise the common interest of all these agencies in receiving, treating and distributing documentary material.

THE thirty-fifth annual general meeting of the Institution of Mining Engineers will be held at the Conference Halls of the British Empire Exhibition on Thursday and Friday, October 2 and 3. Sir John Cadman will relinquish his third term of office as president on October 2, when he will be succeeded by Dr. J. S. Haldane, Director of the Mining Research Laboratory and honorary professor in the University of Birmingham.

M. MENGÈS, whose recent book was noticed briefly in NATURE of July 19, p. 85, writes to suggest that we misinterpreted him. In reply we would explain that the phrase "proposes in some measure to revert to the older 'classical' conceptions" was not intended to throw any doubt on the novelty of his ideas. It was only intended to indicate that his theory approximates more nearly to classical than to relativity theories.

AT the opening session of the annual autumn meeting of the Institute of Metals, held at the Institution of Mechanical Engineers, London, on Tuesday, September 9, Prof. T. Turner referred in his presidential address to the growing needs of the Institute in view of the steadily increasing membership, the growth of the library, and the greater use by members of the facilities which are provided. Additional funds are required if the work is to be maintained and extended; and the alternative to a further increase in the annual subscription is an endowment, the proceeds of which would be available for providing the necessary additional accommodation and assistance. Prof. Turner was able to announce a gift of 1000*l.* towards such an endowment. This donation is the largest single gift which the Institute has received, and the Council will shortly take into consideration the question as to how far, and in what manner, it may be made the basis of a larger scheme.

Two junior assistants are required by the Research Department, Woolwich, for analytical work in connexion with Internal Ballistics problems. Candidates must possess first-class honours in mathematics. Written applications, with copies of testimonials, must be sent to the Chief Superintendent, Research Department, Woolwich, S.E.

WE have received from Messrs. Boots their list of special research chemicals. We note that the number of these has increased considerably, and that a great majority of the compounds are manufactured or purified in Messrs. Boots' own laboratories in Nottingham. As manufacturers and distributors of fine chemicals, Messrs. Boots are in a position to supply, in a state of considerable purity, many of the intermediates and raw materials which are of interest to workers engaged in chemical research.

Two useful catalogues of second-hand books offered for sale by Messrs. Bowes and Bowes, Trinity Street, Cambridge, have reached us. One (No. 422) is of a miscellaneous character dealing with works of biography, sport, travel, English topography, general literature, and of foreign origin. The other catalogue (No. 423) contains particulars of nearly 3000 works relating to mathematics, pure and applied; including physics, astronomy, meteorology, electricity, engineering, assurance, insurance, etc. The catalogues are obtainable from the publishers upon request.

Our Astronomical Column.

STATISTICS ON STELLAR VELOCITIES.—One of the chief factors in the rapid progress made in recent years regarding stellar distribution and motion has been the substitution of accurate statistical methods for the haphazard investigations of earlier times, which were often based on incomplete material. The *Astroph. Journ.*, June 1924, contains two important statistical papers by Prof. F. H. Seares.

The first deals with stellar velocities, and demonstrates the soundness of Schwarzschild's assumption that the logarithms of the tangential velocities (*i.e.* the velocities deduced from observed proper motion, after correcting for the sun's velocity), for any assigned absolute magnitude, conform very closely to the Gaussian error-curve, sometimes designated "the cocked hat." A similar conclusion is reached for the radial velocities.

The second paper seeks to find a formula for the relative numbers of stars of different absolute magnitudes. The well-known difficulty is present that the extreme dwarfs are invisible unless their distance is small, so that it is impossible to test any region except that adjacent to the sun.

Kapteyn and van Rhijn deduced the mean parallax formula $\log \bar{\pi} = -0{\cdot}690 - 0{\cdot}0713m + 0{\cdot}645 \log \mu$, m being apparent magnitude and μ proper motion. This is shown to agree well with observation for stars for which M is brighter than 8 mag.; but the number of absolutely faint stars is far greater than that indicated by the formula.

The paper emphasises the urgent need of obtaining more parallaxes of these faint stars.

THE THERMOPILE USED FOR MEASURING STAR MAGNITUDES.—Allusion has already been made in this column to the use of the thermopile for measuring the total absorption by a star-image of a beam of light passed through a photographic plate. The method has the advantages of being free from personality and of giving the integrated effect of the whole image independently of the distribution of density in different parts of it. It is thus available in reflector plates to a considerable distance from the centre of the plates in spite of the winged character of the images. Groningen Kapteyn Lab. Publ., No. 32, contains an investigation by J. Schilt which confirms the accuracy and convenience of the method. It has been applied to several of the Cape Phot. Durchm. plates with good results, also to some plates taken with the 60-inch reflector at Mount Wilson.

Stars of determined magnitudes are used for calibrating the curves derived from the thermopile readings; these are taken from the investigations of Seares (Mount Wilson), Chapman and Melotte (Greenwich), and Dziewulsky (Potsdam). It is suggested that the method may usefully be applied to the magnitudes of stars in the Durchmusterung of selected areas.

SOLAR APEX AND VELOCITY.—*Astr. Nach.* 5312 contains a paper by B. Fessenkoff and C. Ogrodnikoff on the solar apex and velocity as deduced from the radial velocities of stars of type B. This method of deducing the apex is a useful check on the method from proper motions. The latter is very sensitive to the effect of systematic errors in the older catalogues, as Kapteyn pointed out. The B stars were selected as being of high mass and small peculiar motions.

Four solutions are given, according to the assumed K effect or the shift of spectral lines arising independently of radial motion. They do not differ very largely *inter se*; in that adopted as most probable, K is taken as corresponding to an apparent recession of 3·15 km./sec. According to this, the sun is moving towards R.A. 265·8°, N. Decl. 31·9° at a speed of 21·7 km./sec.

Research Items.

ROUND BARROWS AND THE STUPA.—In the *Ceylon Journal of Science* (vol. i., part 1, section G.) Mr. A. M. Hocart argues for a connexion between the round barrows of prehistoric Europe and the stupa or tope of Indian and Cingalese Buddhism, adapting a theory of Fergusson's in the light of more recent knowledge. Senart, in opposing Fergusson's view, derived the stupa from the fire temple, connecting it with the solar origin to which he assigned much in Buddhism. There is, however, evidence that the stupa is essentially connected with relics, like the altar of the Roman Catholic Church, and, according to tradition, was erected over the ashes of an emperor and his family. The name *caitya* given to a tope indicates its connexion with the funeral pile, and the bo-tree invariably associated with the tope in Ceylon, to which the term *caitya* is also applied, is probably a tree planted to mark the spot of cremation. The original object of the round barrow and the stupa, therefore, appears to be identical, the fact that brick is employed in one case and earth in the other being immaterial. Further, it is possible that there may be some connexion between the round barrow and the sacred mounds of Fiji, the link being the Basarh mounds, which appear to relate to the latter through a legend of the origin of earthen mounds which, with certain modifications, is common to both.

PREHISTORIC REPRESENTATIONS OF THE HUMAN FORM FROM MALTA AND GOZO.—Dr. Zammit and Dr. Singer have contributed to the Journal of the Royal Anthropological Institute (vol. liv. pt. 1) a comprehensive study—the first to appear—of the interesting statuettes of neolithic age discovered from time to time in the megalithic structures of Malta and Gozo. The statuettes are, with three exceptions, made from local material, the majority being either of globigerina limestone or clay. In the greater number the most prominent characteristic is their obesity, sometimes, but erroneously, called steatopygia. They are classified into four groups—idealised representations, male and female, portrait models, representations of priests or temple officials, and votive offerings. The first group is that in which the obesity is most marked. The buttocks, thighs, legs, arms, and chest are enormously fat; but the head, when present, and the neck are free from fat, while the hands and feet are in all cases small. Taken in conjunction with other characters, these features suggest that a well-known pathological condition has been taken as a standard and has developed into a ritualistic convention. The figures are comparable with representations of the human form in palæolithic art, and similar figures have been described from Crete, the Cyclades, the Morea, Thessaly, Servia, Egypt, Erythrea, and elsewhere. Certain characteristics, however, separate them from all these except perhaps in the case of Thessaly. It is suggested that they may be a specialised local form, coarse and crude, of an art well known from Crete.

THE MAPPING OF OCCUPATIONAL GROUPINGS.—In a series of Norwegian studies published in the *Sociological Review* for July, Mr. A. Farquharson has made some interesting attempts to map occupational groupings in connexion with a discussion of Aandlesness and its occupations. The principle adopted in the experimental coloured map of about $\frac{1}{8}$ sq. mile of the Aandlesness promontory is based on an eightfold division of simple occupations. These are miner, woodman, hunter, shepherd, upland farmer, lowland farmer, market gardener, and fisherman. For each of these a different colour symbol is used. The derived occupations are indicated by numbers printed over the colour symbols. Thus the derived occupations from mining include smith, tinsmith, stonemason, etc., while, as regards fishing, distinctions are drawn between sea-fishing, fish-curing, and the selling of fish. This classification has the advantage of being evolutionary and indicates the link between simple and more developed occupations, but there are of course cases in which the links are not clear, and could be traced only by research in the particular case and place. In putting forward this tentative scheme, Mr. Farquharson emphasises the need of distinguishing between craft occupations, using the term in a general sense to indicate the making and growing of things; clerical employment; and intermediate occupations such as transport and distribution. The difficulties of this sociological mapping are great, but this attempt is most suggestive of the results obtainable.

VOLCANIC ISLANDS IN THE CHINA SEA.—Two new volcanic islands were reported as having appeared in the China Sea in the eruption of 1923 in approximately lat. 10° 9′ N., long. 109° E. The *Geographical Journal* for August contains a note regarding this occurrence, based on information supplied by the Admiralty. In March this year, H.M.S. *Iroquois* found that both islands had disappeared, and that their sites were covered by water of a depth of about 50 fathoms. The examination also failed to reveal any trace of the 12-fathom bank in the vicinity which had been reported at the same time as the islands. Both the islands and the shallow bank have been omitted from the charts of the China Sea, but caution is advised when navigating in the neighbourhood.

LOAD LINE (ZONES) COMMITTEE.—The report has recently been published of a Committee appointed by the Board of Trade to consider the weather conditions obtaining on the various sea routes of the world, and to advise, having regard to those conditions, to what geographical zones, and what seasons of the year, the application of the special seasonal conditions of loading prescribed by the British Tables of Freeboard may properly be extended. The procedure adopted by the Committee was in the first place to determine the geographical areas in which similar weather conditions exist, and then to study these areas in detail in order to decide what loading restrictions would be necessary. The final recommendations of the Committee are very clearly indicated in a chart of the world printed as an Appendix to the Report. In this chart are shown (*a*) the regions in which winter freeboard should obtain for the whole or part of the year, (*b*) the regions where summer freeboard should obtain for the whole year, (*c*) the regions where weather conditions are more stable than ordinary summer conditions, and in which the deeper "Indian Summer" loading should be permitted, and (*d*) the areas which are specially liable to hurricanes, with a statement in each case of the hurricane season. With regard to the hurricane areas, the Committee did not feel justified in recommending that any new restrictions should be imposed on account of hurricanes, as the number of casualties due to hurricanes, though not accurately known, is small; and in the seasons when hurricanes occur the weather conditions are otherwise favourable. The Committee strongly recommended the issue of a warning to owners and masters of ships which pass through the areas where hurricanes occur that special caution should be observed within those areas, use being made of the rapidly improving facilities for broadcasting weather warnings by wireless telegraphy.

LEFT-HANDEDNESS, STAMMER, AND SQUINT.—The modern tendency to seek for psychological causes for all ailments, whether physical or mental, finds notable expression in a recent article in the *Lancet*, where Dr. W. S. Inman, an ophthalmic surgeon, discusses the origin of squint, left-handedness, and stammer. The connexion between left-handedness and stammering has been observed before, and various attempts have been made to explain it; but always on physiological grounds. Dr. Inman's special contribution to the subject is twofold. While not denying that the causal relation is in many instances to be found in the nervous system, he abandons that line of inquiry and devotes his attention to the discovery of mental causes; and he brings in squinting as a third member of a related group. What he says, in effect, is that left-handedness, stammering, and squinting are but different ways in which the organism responds to emotional stress. The too severe exercise of parental authority in the home, for example, may give rise to left-handedness in one member of the family, to stammering in another, and to squinting in another; or two or three of these peculiarities may appear in any one member. A congenital tendency is, of course, presupposed, for it is well known that each of these defects runs in families. The important point, however, is that the family which is predisposed to any one of these defects is also predisposed to the other two: which of them will actually appear depends upon the general disposition of the person concerned. Dr. Inman thus contends that a self-reliant lad with a strain of perverseness or contrariness in his nature will become left-handed as an unconscious revolt against authority. It is the lad's way of showing that he is "again the government." Gentler natures are prone to respond to the pressure of authority, or the stress of fear, by squinting. Dr. Inman has opened out an interesting line of inquiry which may lead to important results. The cases he cites form strong presumptive evidence of the general soundness of his views.

ANIMAL PARASITOLOGY. — In a recent address (*Science*, vol. 49, pp. 306-310, 1924) on present lines of attack on animal parasitology, Prof. H. B. Ward referred to the recent rapid development of this subject, which has grown more in the last decade than in the whole previous period of recorded science. He pointed out that methods for limiting the attacks of parasites upon their hosts have outrun, in many cases, the information concerning the structure, development and bionomics of the causal organisms, and also of their transmitting agents, if any, and that therefore additional information concerning the parasites is the first necessity for further progress. He emphasised the need for the careful study of the morphology and differential characters of parasites and for examining the original specimens of a species or of material collected in the same locality and from the same host species. He remarked that problems of epidemiology are fundamentally dependent for their solution upon the correct determination of the life-cycles of the parasites concerned, and referred to the confusions which have occurred through faulty determinations. He rightly directed attention to the success of intensive studies on the parasites of lower animals, where continued observation and experimental and close control of conditions, essential for the thorough testing of the results, are possible, and he strongly advocated the closer co-operation of parasitologists and of specialists in the field of medicine.

MINERALS OF THE PRE-CAMBRIAN IN CANADA.—Dr. C. V. Corless recently read a paper before the Royal Society of Arts on the mineral wealth of the Pre-Cambrian in Canada, which is printed in the Society's Journal of August 15. He showed that the Pre-Cambrian rocks occupy an area of some 2 million square miles, and that only a very small portion of this area, little more than the southern fringe, has been prospected. He pointed out that the Pre-Cambrian rocks in the United States contain the Lake Superior iron mines, which produce the great bulk of the iron ores forming the basis of the vast iron and steel industry of the United States, and the Michigan copper mines, which have long ranked among the important producers of that metal, whereas the same rocks in Canada contain the Sudbury nickel-copper mines, the Cobalt area silver mines, and the Porcupine area gold mines, and that gold has been found widely distributed throughout a great proportion of the Pre-Cambrian hitherto investigated. So far as geological investigations have gone, the general character of the Pre-Cambrian rocks is, broadly speaking, uniform, and Dr. Corless infers "that similar mineralisation would broadly follow similar geological conditions because of the wide geological uniformity proven to exist"; he therefore asks the question: "Is it not a reasonable certainty that the achievements of the past both in discovery and in recovery of minerals in but a few per cent. of the total area will be repeated over and over again in the great Pre-Cambrian area as a whole?" He concluded by stating that he for his part has become fully convinced that the inference regarding the vast mineral wealth of the Pre-Cambrian will be found to be true, and that intensive prospecting within this area promises to yield results of great value.

WAVE-POWER TRANSMISSION.—The Constantinesco system of wave-power transmission has been applied successfully to the synchronisation of the firing of machine-gun bullets from an aeroplane and to the Dorman Long boring machine. In his book "Sonics" the inventor investigates this system, taking leakage and friction into account, and obtains a series of equations which show remarkable similarity to those found in the investigation of long-distance telephone-lines. In the *Philosophical Magazine* for July, Lieut. E. A. Barclay-Smith attempts to expound the phenomena occurring in wave-power transmission and to formulate an easy method of investigating them from first principles. He also gives an indication of the line of investigation to be followed when the data are such as will be met with in practice. The essential feature of this system of power transmission is the production of waves in fluid contained in a pipe by means of a reciprocating plunger at one end; at the other end of the pipe is a motor plunger which is reciprocated by the pressure waves in the liquid. The pipe may have several branches leading to different plungers so that power may be received by several machines. The author first investigates a single pipe full of fluid when a plunger starts to reciprocate at one end and neglects friction and leakage, and he shows that there is created a series of pressure-waves, each accompanied by its corresponding particle-velocity wave and travelling to and fro along the pipe, and he explains how the conditions at any point may be ascertained if those existing at some other point are known. Inertias and hydraulic capacities are then considered, the latter being of two different kinds. Then follows an investigation of the simplest practical case, namely, a generator and motor at either end of a uniform pipe. Three cases are examined: (*a*) The motor piston is fixed; (*b*) the motor piston is oscillating but absorbing no power; (*c*) the motor is absorbing power. The contents of the paper are valuable, but will require considerable amplification before they can be of service to the practical designer.

Germination of Seeds exposed to Low Temperatures.

By H. F. ROBERTS, University of Manitoba.

THIS investigation was undertaken in December 1921. Seeds of thirty species were placed in tin containers (druggists' ointment tins), one lot being left indoors in the laboratory, at a temperature of 75° F., the other lot being exposed out of doors, for 83 days, from January 9 to April 2. In both cases the seeds were kept perfectly dry. After the conclusion of the period indicated, the seeds of both lots were germinated between blotters for 10 days in the laboratory, at a temperature of 72°-75° F. One hundred seeds were tested from each lot, the germinated seeds being counted on the fifth, seventh, and tenth days. Fifteen varieties of garden seeds, belonging to seven species, gave a germination percentage at the end of 10 days of 67 per cent. to 63 per cent. in favour of the indoor lots. For eleven varieties, belonging to eight species, the germination percentage at the end of 10 days was as 70 per cent. to 66 per cent., also in favour of the indoor lots. The twenty-six varieties gave an average percentage germination at the end of 5, 7, and 10 days of 42 : 36, 62 : 58, and 69 : 65 respectively, for the indoor and the outdoor lots, or a preponderant percentage superiority of 6 per cent., 4 per cent., and 4 per cent. respectively, for the three successive periods, in favour of the lots kept indoors.

From the above summary, it appears that a small average increased germination percentage occurred in the case of seeds kept at laboratory temperature. It was noticed that the seeds of cool temperate species developed a germination percentage higher by 25 per cent. (54 : 20) than those of the warm temperate species kept at laboratory temperature, during the first 5 days of the germination period, although the increased percentage was but 14 per cent. (43 : 29) in favour of the same group exposed to the outside winter temperature. The total germination percentage, however, was approximately the same in both cases.

The mean temperature out of doors for the period of the experiment was as follows, in degrees Fahrenheit: Jan. +3·0, Feb. +0·4, Mar. +24·7, Apr. +41·5, May +60·0.

In the winter of 1923, another lot, consisting of fourteen species, in thirty-three varieties, all of them cool temperate vegetable and field seeds, were exposed as before on January 26. On May 12 the different lots of seeds were tested for percentage of germination. In the preceding year's experiment the germination test was made in the laboratory for plant physiology of the University of Manitoba. In the second year the germination tests were conducted in the official Dominion Seed Laboratory at Winnipeg. The results obtained were as follows: As the average of the summary shows, there was a difference of 4 per cent. in favour of the seeds kept at laboratory temperature,—about 2 per cent. less than the average at the end of 10 days for the twenty-six species and varieties tested the preceding year. At all events, the results, although not conclusive, at least point to a slight diminution in total vitality, as the result of continued exposure to low winter temperatures at the latitude of Manitoba. It should be stated that all the seeds tested were in a thoroughly air-dry condition before the beginning of the test.

Sixty-six varieties, belonging to fifteen species, were tested, including carrot, Swedish turnip, mangel, sugar beet, barley, flax, crimson and white clover, cucumber, cauliflower, celery, egg plant, and cabbage. The total averages for all varieties tested were as follows:

	4-day test.	10-day test.
Inside . . .	56	73
Outside . . .	57	75

There is therefore seen to be practically no difference in the results as between the seeds kept indoors and those kept outside. If some of the individual cases are examined separately, three varieties of carrots gave at the final test 69 per cent. and 68 per cent. respectively for the seeds outside and inside; six varieties of Swedish turnip, 75 per cent. and 75 per cent.; three varieties of mangels, 56 per cent. and 62 per cent.; three varieties of turnip, 71 per cent. and 73 per cent.; three varieties of cucumber, 79 per cent. and 81 per cent.; four varieties of cabbage, 98 per cent. and 77 per cent.

It thus appears, when the details can be taken in numbers sufficient to indicate an average result, that the data agree with the general average. Inasmuch as the data herein are at variance with the general experience of practical men, horticulturists, etc., with regard to the practical utility of chilling seeds, it is concluded that the general factor of moisture is the effective one, and that the layering of seeds in a moist substratum accounts for the effectiveness of the practice, rather than the temperature factor alone.

Barogram Analysis in Weather Forecasting.

THE Italian meteorologist, Francesco Vercelli, has made a laborious study of barographic records from various parts of the world, and various periods and seasons, submitting these curves to a process of periodigram analysis on the lines familiar in tidal investigations, or as applied to the study of seiches in lakes by the late Prof. Chrystal. The results are described in full detail in a booklet published last year in Rome, under the auspices of the Geophysical Institute of Trieste, entitled "Nuovi esperimenti di previsioni meteorologiche."

From the generalised point of view, the barometric curves are shown to contain the well-known diurnal period which is so outstanding in the tropics, various periods ranging between a few days and a month, and an annual period, together with a small "insoluble residue," representing what must be regarded as irregular fluctuations. The amplitudes of these several periods, and other characteristics thereof, differ greatly according to latitude, season, and continentality. If the periodal composition of a given barogram is known, it becomes possible to synthesise its prolongation on the assumption that none of the contained periods die out or others reappear, and thus to make a forecast of the course of barometric pressure for a longer period than is possible by the ordinary synoptic chart method.

Vercelli claims—and the responsibility for the statement must rest with him—to have obtained remarkably good agreement between the predicted and actual continuations of his curves, and to have used this method of weather forecasting with much success in circumstances of grave responsibility on the Italian Front during the War. He indicates the main source of error to be the liability to cessation, or temporary suspension, of any of the component periods, or the reappearance of others. He also points out that the paper in question, discussing the analysis of

single curves, is only the commencement of the subject, since the next step will consist in co-ordinating the analyses of curves from several places; this would greatly enhance the usefulness of this method of forecasting.

The author does not, however, appear to lay enough stress on the fact that forecasting pressure is by no means equivalent to forecasting weather, and that the correlation between rainfall and the height of the barometer at a place, or even the connexion between rainfall and pressure distribution over an area, is none too close from a forecaster's point of view. One has also to consider the tendency of the weather to get into dry or wet "grooves"; for it is well known that during pronouncedly wet spells, downpours occur in passing barometric configurations that would scarcely yield a drop during a dry spell. Moreover, it does not follow that Vercelli's method, even if found practicable in Italy, would answer in England, where it is possible that the relationship between pressure and weather may be rather more complex. It is just such climatic peculiarities we want to discover, and it is not too much to say that even if a universal application of Vercelli's system to weather forecasting proved wholly unserviceable, which is scarcely likely, it could not fail to bring to light any such interesting climatological differences between one region and another. L. C. W. BONACINA.

Wind, Wave, and Swell on the North Atlantic Ocean.[1]

DURING a voyage from Southampton to Trinidad and back by R.M.S. *Oruba* the period of the waves was taken several times daily, and from this their speed was calculated. The speed of the wind was ascertained by means of a Robinson anemometer (lent by the Meteorological Office), due allowance being made for the speed of the ship and the direction of the wind.

The water is very deep from a short distance beyond Ushant, and free from strong currents so far as Barbados. The speed of the wind ranged from 13·9 to 23·6 statute miles per hour. That of the waves was in all cases less, the difference ranging from 1·0 mile an hour to a little more than 8·0 miles an hour. The latter is sufficient to keep a light flag flying. Anything less than 1 mile an hour is reckoned a calm. The difference was not proportional to the speed of the wind; nevertheless a relationship emerges when account is taken of the observations which were made simultaneously of the swell of the sea. When swell and wave ran precisely in the same direction (as sometimes occurred in the region of the Trade winds) and on one day when no swell was recorded, the speed of the wave was so nearly equal to that of the wind that the breeze blowing over the ridges was only equal to the "light air" which barely suffices to give steerage way to a fishing smack. Such a light air would be detected on land by drift of smoke but would not move a wind-vane. Thus there was no longer a battle between wind and wave.

When the swell followed but crossed the wave the difference in speed of wind and wave was greater, and this difference increased rapidly when the crossing swelling swell was meeting, instead of following, the wave. When the waves were much slower than the wind their height was always small, and sometimes their fronts were short and irregular. It was evident that the growth of waves in both length and height was much hindered by a crossing swell, and it can be safely inferred that the general absence of swell is a sufficient reason for the rapid rise of waves upon enclosed seas. When a wind comes on to blow in the direction of the ocean swell with a speed greater than that of the swell, the growth of large, steep waves is very rapid (doubtless even more rapid than their growth from smooth water), but this occurrence is relatively rare in the North Atlantic.

The direction of the breaker out at sea was found to be intermediate between that of wave and swell (the breaker being formed when they override), so that the practice of observing the direction of "the curl on the water" as a method of determining the direction of the wind gives an erroneous result whenever there is a crossing swell, which is the usual condition upon the oceans. The general run of the waves, on the contrary, gives a trustworthy indication of the direction of the wind.

[1] Substance of a paper by Dr. Vaughan Cornish read before Section E (Geography) of the British Association at Toronto on August 8.

Mountain Structure.

THE origin of mountains continues one of the most controverted problems in geology, because geological maps of mountain areas are most difficult to prepare, and the interpretation of mountain structure involves appeal to layers of the crust far too deep for direct observation. The American Geological Society has arranged a symposium of nine papers on the development of mountains,[1] which is the best available summary of modern opinion on the subject and illustrates its diversity.

The series opens by a masterly sketch by Prof. Schuchert of the development of research on orogeny from its foundation by H. H. Rogers, and of the evolution of North America, illustrated by 17 maps. He compares the American school with Haug's view of geosynclinals, which he rejects as untenable. Amongst several useful new terms proposed is "tafrogenesis" for rift valley formation.

Mr. Longwell's paper on Kober's theory is appropriate, as it deals with an extension of the subsiding belt explanation of mountain formation. Kober reclassifies the Alpine elements to avoid that asymmetry in mountain chains which Suess emphasised as their distinctive feature. Prof. Hobbs rejects Suess's arrangement of the Asiatic arcs, and assigns many of them to a direction of movement opposite to that adopted by Suess.

The structure of Appalachia naturally plays a large part in the symposium, and is discussed by J. B. Woodworth and Arthur Keith, whose conclusions are opposite. The former adopts isostasy, which Keith criticises adversely. He attributes the Appalachians to the intrusions of many granitic batholiths; in a valuable discussion of rival theories he rejects the shrinkage of the earth, owing to the astronomical disallowance of the necessary reduction in size; but if the geological evidence for the contracting earth is adequate the astronomers will doubtless find some reconciliation of that fact and their calculations.

The structure and building of the Rocky Mountains is discussed by G. R. Mansfield and W. T. Lee, whose paper is accompanied by appendices by C. E. Van Ostrand and W. D. Lambert. Mansfield rejects Kober's view that rift valleys are accompanied by compression, and insists that they are due to tension. Lee describes the Southern Rocky Mountains as due to vertical uplift in the restoration of isostatic equilibrium.

[1] Symposium on the Structure and History of Mountains and the Causes of their Development. Bull. Geol. Soc. Amer., Vol. 34, Pt. 2, June 30, 1923, pp. 151-380, 1 pl.

University and Educational Intelligence.

CAMBRIDGE.—As was reported some months ago, the Rockefeller Trustees offered to build a School of Pathology for the University, and to endow it partly, if the University could provide from other sources the sum of 33,000*l.* as a share of the total expense involved. It is now announced that Mr. Ernest Gates, of Norfolk, has offered the sum necessary to complete the 33,000*l.*, and is thus enabling the University to accept the generous offer of the Rockefeller Trustees.

LONDON.—A course of 24 university extension lectures on "The History of Science" will be given at Gresham College, Basinghall Street, E.C., by Dr. C. Singer, beginning on September 29. The first lecture will be free. A course of instruction in geography has been arranged for delivery at the Westminster Training College, Horseferry Road, S.W., to one year full-time students and four year part-time students. Particulars of these and other courses of lectures on science, geography, history, literature, economics, art, etc., may be had from the Registrar, University Extension Board, University of London, South Kensington, S.W.7.

MANCHESTER.—In connexion with the department of Bacteriology and Preventive Medicine, a diploma in bacteriology has been instituted and a course of instruction for graduates in medicine or in science will be started in October. It is requested that intending candidates for the diploma shall send their names to the director of the Public Health Laboratory, York Place, Manchester, from whom further particulars can be obtained.

OXFORD.—Applications are invited for two research assistantships in the Institute of Agricultural Engineering. Candidates must have had specialised training and experience in advanced physics and electrical engineering respectively. Particulars and application forms are obtainable from the Director of the Institute, 65 St. Giles', Oxford.

UNIVERSITY COLLEGE, Reading, and the Berkshire Agricultural Instruction Committee invite applications, up to September 29, for the post of Instructor in Beekeeping for Berkshire. Particulars may be had from the Agricultural Organiser for Berkshire, University College, Reading.

APPLICATIONS are invited for the professorship of electrotechnics in the University of the Witwatersrand, Johannesburg. Particulars of the position and a form of application are obtainable from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. Applications for the post and copies of testimonials must be sent to the Secretary by, at latest, September 30.

THE Educational Directory, 1924, published by the United States Bureau of Education, containing some 15,000 names and costing only 20 cents, must be invaluable to educationists in the United States, and is not without interest in other countries. The names given are those of presidents, deans, superintendents, and other administrative officers, and there are useful lists of boards and foundations, libraries, associations, and periodicals. The extent to which the summer school system has developed in America is indicated by a list of nearly 900 summer schools.

Early Science at the Royal Society.

September 13, 1666. The Society being taken up for the most part of this meeting with the consideration of the place for their future meetings in that time of public disorder and unsettlement by reason of the late fire, was thereby hindered from making experiments, and discoursing of philosophical subjects, as they used to do.

1677. Ordered, that Mr. Boyle, Sir John Hoskyns, and Mr. Hill, or any two of them do at ten of the clock in the morning go to the widow of Mr. Oldenburg, late secretary of the Society, and demand, receive, or take order for securing, for the use of the Society, all such goods, books, and writings belonging to the Society, as were or had been in the possession of her, or of her late husband.

September 14, 1663. Mr. Oldenburg mentioned, that Mr. Beal was willing to engage in the observation of the weather, and in registering the changes thereof; and that he hoped to set the same at work in other parts of the country; desiring to be furnished with thermometers of the same figure and size. Whereupon Mr. Hooke was ordered to give the operator directions to provide a dozen sealed thermometers with spirit of wine, to be sent to Mr. Beal, and into other parts of the world.

1664. An account was given by the president of some experiments made on the top of St. Paul's steeple: 1. To measure the vibration of a pendulum of 200 feet long. 2. To discover the difference of the weight of bodies on the top of the steeple and below. 3. A repetition of the Torricellian experiment.

September 17, 1662. Sir Robert Moray mentioned a French gentleman, who having been some time in England, and being present at a meeting of the Society, took notice, that the nature of all trees is to run altogether to wood; which was changed by a certain method of cutting them, whereby they were made, contrary to their nature to bear fruit; and that according as this cutting was performed with more or less skill, the more or less fruitful the tree would be. A proposition was offered by Sir Robert Moray about the planting of timber in England, and the preserving of what was then growing.—Dr. Charlton read his discourse entituled "Apparatus Phonocampticus: or what inquiries are principally to be made by such, who would attain to the certain knowledge of the nature of echos," which was ordered to be entered into the book of histories and theories.

September 18, 1661. Mr. Croune produced two experiments, one of the compression of the air with quicksilver in a crooked tube of glass, the nipt end of which broke; and the other with a cork kept down at the bottom of a cylinder of water in a vessel perforated at the bottom, over which the cork was laid; upon stopping of which foramen, and the pouring in of water, the cork immediately rose.—Mr. Boyle gave an account of his having made the former of these experiments by compressing twelve inches of air to three inches, with about an hundred inches of quicksilver.

1666. Mr. Hooke showed his model for rebuilding the city to the society, who were well pleased with it; and Sir John Laurence, late lord mayor of London, having addressed himself to the society, and expressed the present lord mayor's and aldermen's approbation of the said model, and their desire that it might be shown to the King, the president answered, that the society would be very glad, if they or any of their members could do any service for the good of the city; and that Mr. Hooke should wait on them with his model to the King, if they thought fit to present it; which was accepted with expressions of thanks.

Societies and Academies.

PARIS.

Academy of Sciences, August 18.—M. Guillaume Bigourdan in the chair. Notice of the death of J. B. de Toni, Correspondant in the section of botany.—F. E. **Fournier**: Remarks on the interpretations to be given in future to the three special signals defined in the author's note on safety manœuvres for steamships passing each other in fog, published in the *Comptes rendus*, August 4.—S. **Winogradsky**: The microscopic study of the soil. A detailed description of the technique adopted for the direct observation of the soil bacteria, together with a short account of the results obtained.—E. **Mathias**: The noise of the lightning flash. The theory is propounded that the electrical discharge produces endothermic compounds of oxygen and nitrogen of the type O_4, N_4, O_6, N_6 and that the noise of the flash is produced by the explosive decomposition of these substances. According to this theory the flash and noise are not produced simultaneously. No experimental evidence in support of the theory is given.—Charles **Nicolle**: Contribution to the knowledge of obscure infections. Examples drawn from the experimental study of exanthematic typhus. The term *infection inapparentes* is given to a type of acute septicæmic infection, existing exceptionally in the guinea-pig and frequently in the rat. There is no rise of temperature, and the existence of the disease can only be recognised by inoculation into other animals: the condition is quite distinct from what has been termed latent infection.—H. **Mineur**: The analytical theory of continued finite groups.—M. **Paschoud**: The problem of uniform regime in a fine tube the section of which is an isosceles right-angled triangle.—Carl A. **Garabedian**: Four methods for solving the problem of the rectangular beam.—Antonio **Cabreira**: The determination of geographical latitude, any three altitudes and the declination of the star being known.—Ernest **Esclangon**: The total eclipse of the moon of August 14, observed at the Strasbourg Observatory.—L. **Dunoyer** and P. **Toulon**: Some electro-mechanical applications of arc relays with external sheath.—Carl **Benedicks**: Method for the determination of the density of iron and of other refractory metals in the liquid state: an extension of the hydrostatic method of Dulong and Petit. The density of liquid iron at 1540° C. was found to be 6·92±·07.—C. **Gutton** and G. **Laville**: Electrometric measurements of very small alternating potential differences.—R. **Bureau** and A. **Viant**: Meteorological conditions and the appearance of certain atmospheric disturbances in receiving apparatus of wireless telegraphy. Atmospherics are always connected with invasions of polar air and are removed by the arrival of a warm front.—André **Graire**: The reversibility of the reactions of sulphuric acid formation in leaden chambers. Evidence of the reduction of sulphuric acid to sulphur dioxide by nitric oxide, reversing the ordinary reaction forming sulphuric acid in the leaden chamber.—Mme. Pauline **Ramart**: Molecular transpositions. Identification of the products of dehydration of 1.1.3-triphenyl—2.2-dimethyl—1-propanol.—H. **Gault** and B. C. **Mukerji**: The formation of hydrocellulose.—G. **Vavon** and A. **Couderc**: The isomerism of menthol and neomenthol. The addition of hydrogen to menthone, in the presence of platinum black, gives a mixture of stereoisomers in which neomenthol (cis) predominates over ordinary menthol (trans).—R. **Fosse**, Ph. **Hagene**, and R. **Dubois**: Researches on a new method of quantitative analysis of cyanamide in its calcium compound.—P. **Nottin**: The estimation of maltose in the presence of other reducing sugars by means of Barfoed's solution.—Alfred **Schoep**: Sklodowskite, a new radioactive mineral. This was found in the Belgian Congo, in a layer containing several uranium minerals. Its composition is $MgO \cdot 2UO_3 \cdot 2SiO_2 \cdot 7H_2O$ and it has tellurium, nickel and alkalies as impurities.—R. **Verneau**: Recent prehistoric discoveries in Indo-China. These deposits were found in caves in the Bac-Son limestone massif, and have furnished several thousands of stone implements.—L. **Blaringhem**: The degenerescence of flax.—L. **Emberger**: Contribution to the study of the formation of plasts in plants.—G. **Ramon**: The properties of diphtheric anatoxine. The anatoxine, the preparation of which was described in an earlier communication, retains its immunising properties for long periods (twelve months) if kept in an ice box (3° to 4° C.). Keeping does not develop any toxicity, and the properties are unchanged after heating to 65°-70° C. for one hour.——**Simionesco** and André **Lancien**: The influence of the cinnamic radicle on the stimulation of the hæmatopoietic organs.

Official Publications Received.

Agricultural Experiment Station, Michigan Agricultural College. Special Bulletin No. 125: Michigan Potato Diseases. By G. H. Coons and J. E. Kotila. Pp. 55. Special Bulletin No. 129: Bean Growing in Michigan. By J. F. Cox and H. R. Pettigrove. Pp. 21. Special Bulletin No. 130: The Clovers and Clover Seed Production in Michigan. By J. F. Cox and C. R. Megee. Pp. 23. Special Bulletin No. 131: Tomato Growing in Michigan. By E. P. Lewis. Pp. 14. Special Bulletin No. 132: Common Pests of Field and Garden Crops. By R. H. Pettit. Pp. 60. Technical Bulletin No. 63: Studies on Michigan Celery Diseases. 2: A Study of the Early Blight Fungus, *Cercospora apii* Fres. By L. J. Klotz. Pp. 43. Circular Bulletin No. 62: The Simplex Lime Spreader. By H. H. Musselman. Pp. 7. (East Lansing, Mich.)

Proceedings of the Aristotelian Society. New Series, Vol. 24: Containing the Papers read before the Society during the Forty-fifth Session, 1923–1924. Pp. ii+272. (London: Williams and Norgate.) 25*s*. net.

University Correspondence College. London University Guide and University Correspondence College Calendar, 1924–1925. Pp. 204. (Cambridge: Burlington House; London: 34 Red Lion Square, W.C.1.) Gratis.

A Catalogue of Scientific Periodicals in Canadian Libraries. Prepared by Dr. Gerhard R. Lomer and Margaret S. Mackay. Pp. xx+255. (Montreal: McGill University.)

Diary of Societies.

MONDAY, SEPTEMBER 15.

CONFERENCE OF ENGINEERING SOCIETIES (at the British Empire Exhibition), at 10.30.—Miss C. Griff: The Working of Stainless Steel.—A. R. Page: Co-operation between the Works Chemist and the Engineer.—T. G. Hunter: Ceylon Plumbago—Its Uses and High Qualities.—A. S. E. Ackermann: Technical Popular Fallacies.

TUESDAY, SEPTEMBER 16.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. C. W. Saleeby: Light and Life.

THURSDAY, SEPTEMBER 18.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Empire Exhibition).—T. W. Barley: A Comparison of Gas and Coke Fired Drying Stoves, together with a Description of the Construction and Operation of the Hüttenes Coke-Fired Air-Blown Furnace.—Prof. J. W. Cobb and H. S. Houldsworth: Some Properties of Clay Silimanite Mixtures.—W. Hugill and W. J. Rees: The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays.—W. Vernadsky: The Action of Heat on Kaolinite and Kaolinitic Clays.—W. J. Rees: Alumina-Silica Minerals in Firebricks.—Dr. J. W. Mellor and A. Scott: The Action of Heat on Kaolinite and other Clays, Part II.—A. Scott: The Origin of the Austrian Magnesite Deposits.—A. Hadding: X-ray Investigation of Clays and other Ceramic Substances: Researches into the Application and Practical Value of the Method.—W. J. Rees: Note on the Storage of Silica Refractories.—W. J. Rees: The True Specific Gravity and After Expansion of Lime-bonded Silica Bricks.—W. Hugill and W. J. Rees: A Rapid Method for the Determination of True (or Powder) Specific Gravity.

FRIDAY, SEPTEMBER 19.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Empire Exhibition.—(For Papers to be communicated see above.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—*Red Book* Night (Affiliation of Photographic Societies with the Royal Photographic Society). The slides selected from the Affiliation lantern slide competition will be shown on the screen, and a criticism on the slides will be made by S. L. Coulthurst.

Supplement to NATURE

No. 2863 SEPTEMBER 13, 1924

The History of Scientific Thought.

By W. C. DAMPIER WHETHAM, F.R.S.

THE earliest form of history is a chronicle of priests and kings with their attendant worshippers and warriors. The misty dream of god-descended heroes passes into the clear vision of the ordered march of Roman legions; the picturesque pageant of medieval bishops and barons vanishes in the smoke of Bosworth field; and the sound of Drake's guns, drumming the Spaniards up the Channel, melts into the strains of a Te Deum, sung in Notre Dame for another victory over Marlborough.

Then Clio discovers politics, and tells us of statesmen and of constitutions. Pericles and Cicero, Richelieu and Walpole, Magna Charta and the Petition of Right, the Declaration of Independence and the French Revolution (with appropriate footnotes on contemporary literature and art), are acclaimed as the proper study of mankind. The old idea of a Garden of Eden or a golden age of heroic kings in the past changes into the equally pathetic delusion of certain and continued progress in the future, necessarily linked with the growth of political democracy in the present.

So historians taught when our fathers were young. Then came Thorold Rogers and William Cunningham, who first saw the importance of economic history, while Maitland was putting new life into the chronicles of Law and Constitution by the study of records. Underlying the froth and glitter of politics and war, we were shown the deep and steady currents of economic change. Control of the trade routes of the ancient world, the rise of European prices due to the gold of Mexico and Peru, the coal of England burning into power in the pioneer factories of the world, were realised as more mighty than the beauty of Helen or the valour of Achilles, the will of Popes or the ambition of Kings, the genius of Napoleon or the lure of Reform Bills. And the believers in sudden Utopias, disillusioned by this time of political reform, hastened to become economic socialists.

But now men begin to ask how these resistless currents of economic change are started, and what determines the channels in which they flow. It is clear that our varying control over the resources of Nature is one factor involved. When bronze could be used instead of stone and flint, when fresh-forged iron replaced the softer bronze, new industries appeared, and the efforts of men were perforce turned aside to develop and exploit them. The making of gunpowder pierced the knight's bright armour and levelled the baron's frowning walls, to spread abroad the King's peace and liberate the trade of towns. Tull's discoveries in the art of growing field-crops, and Bakewell's study of the methods of stock-breeding, gave food for the rapidly growing population, called into being by the energy of coal, converted in the factories built to meet the inventions of Watt and of Arkwright.

This harnessing of Nature's fiery steeds of power is one of the two functions of that ordered knowledge we call science, and, conversely, the material wants of man give one of the two motives from which pure as well as practical science springs. Geometry arose from the need for the repeated mensuration of land after the yearly flood of the Nile; astronomy began as the bye-play of Chaldean astrologers, seeking, by the dim light of the stars, to peer into the future and thus control the destinies of man; thermodynamics was developed to explain and improve the working of the steam-engine.

But another desire is also at work to generate science, and another function is fulfilled by science when born. Man does not live by bread alone. The longing of the soul for light, of the brain for knowledge, is a nobler if a rarer instinct than the craving of the body for food and shelter. The mystery of existence, the eternal riddle of the Sphinx, moves the mind of the philosopher, and, when he learns to humble his hopes and advance step by step on the slow road of observation and experiment, he becomes a man of science and gains an ever-increasing insight into the secrets of Nature.

So it is that history, to become a complete record of man's story, must take account of his intellectual as well as of his material achievement. Thus alone, when the history of thought is combined with that of action, can we watch in its fulness the great human drama, and write in worthy form a Universal History of the World.

Moreover, to do this as it should be done, we must call to our aid the transforming magic of literature. Our poets must not only sing of burning Sappho or the hills of Rome, of Ivry or of Waterloo, of fights for

freedom or of legal progress broadening down from precedent to precedent. They must tell us also of Newton and of Einstein; of the busy laboratory and the mountain observatory; of the spiral nebula whirling from its arms new stars into the dark abyss of space, and the hundred million years of organic evolution; of the lion-haunted dreams of early cave-men, the rise and fall of succeeding civilisations in the long history of the world, and the majestic march of modern knowledge—perhaps but starting on an illimitable progress towards the moral and material betterment of all mankind, perhaps doomed to check and dissolve once more amid the social and economic dangers of our great democratic experiment. There is romance enough in the story of the past, in the veiled mystery of the future, to give a theme worthy of Shakespeare or of Sophocles.

This vision of science as the uniting link between the intellectual and the practical efforts of man, the worthy subject of history and of literature—a vision hitherto seen by few—is at length becoming clear to many. Darwin fluttered some ecclesiastical dovecots; but now for thirty years a cumulative series of striking discoveries has awakened the imagination of all educated men. Röntgen's X-rays, the sub-atomic electron of Thomson, the radioactive disintegration of matter revealed by Rutherford, are paralleled on the biological side by the tracing of the source of malaria, the detection of vitamins, and the application of Mendel's researches to the breeding of new varieties of cereal crops. The War enforced the lesson. Victory was impossible without the aid of the physicist, the chemist, the biologist, and the engineer; and peace cannot bring prosperity and contentment until the electrician has led power about the land, and the economist taught us how best to use and distribute its products.

We see, therefore, a great quickening of interest, not only in contemporary science and its possible applications, but also in the story of scientific development in the past and in the lives of those who have made it. We need but turn over the pages of NATURE for the last few years to see what a change has taken place. Book after book has recently appeared dealing with some aspect of this wide subject, and NATURE itself has helped, both by notices in its editorial columns and by such serial publications as the Calendars of Scientific and Industrial Pioneers and the abstracts of Early Science at the Royal Society.

The universities and schools also are showing more interest in this aspect of science. Mr. R. T. Gunther, led by a chance finding of a collection of apparatus "locked up in a dark cupboard in Christchurch, all smothered with the dust of ages," is publishing a series of studies of early science at Oxford, and Dr. and Mrs. Singer carried on notable research there on the history of science, especially on the biological and medical side, before they moved to London, where a University course of study in the history, principles, and methods of science, leading to an M.Sc. degree, has been established. Sir Clifford Allbutt gives occasional lectures at Cambridge on the history of medicine, and Sir Arthur Shipley on the development of biology.

In schools, nearly all boys now learn some science, and, both for those who are specialising in it and for those whose main intellectual interests lie in other fields of thought, it is well to gain some knowledge of the course of its growth, even to read some of its classical writings. The reports of the yearly conferences of schoolmasters show an increasing appreciation of the advantages of this mode of treatment.

Education is searching for a way of presenting the new humanism. When the works of the writers of Greece were rediscovered at the Renaissance, they were welcomed, not only as history and literature, but also as containing philosophy and science far in advance of anything then known to the modern world. It was natural and right that school studies should be founded on classics, and a classical education was then, and until recent times, the best available. It survived its usefulness, and the inevitable reaction brought into prominence a somewhat academic treatment of mathematics, and a rather inhuman and too odoriferous science. Such studies could not give a complete education, and a tendency to emphasise once more the benefits of classics became manifest.

Science, however, has now reached heights and depths far beyond those that could be touched by the Greeks, and philosophy in the light of science has assimilated the best part of Greek thought and passed on. History and archæology trace the rise and fall of five or more civilisations, in which that known to Herodotus and Livy is but the last before our own, and possess a wealth of records in which a student may learn the delight of research at first hand. The literature of Europe in the last three hundred years can show masterpieces not unworthy of ancient times, and the Gothic cathedral is as noble a building as the Athenian temple.

It is essential to train modern youth to understand and appreciate modern action and modern thought, and a modern humanism is now possible which views classical learning in its right place in a greater whole. In that humanism the history of scientific thought fills a worthy place, and, with a more intensive study of some science itself, may give that open mind and spirit of reverent inquiry into truth which is the essence of scientific method, and the best object of a liberal education.

Science and Literature.

THE rather widespread feeling that science and literature are, in some way, opposed to one another seems, at first sight, inexplicable. For we can say that science is merely a way of ordering experience in terms of certain fundamental principles and concepts, and that literature is a way of ordering experience which employs different principles and concepts. Opposition could arise only if one of these methods professed to be exhaustive and declared that there was no room for the other. But science certainly does not make that claim. No scientific man asserts that the comprehension of a certain region of experience that is given to us by Shakespeare's plays is contained in any scientific treatise, and although we are frequently told that some poet or philosopher has anticipated some great scientific theory—*e.g.* Einstein's—it is probable that this statement is not intended seriously. Yet it is true that there are many literary men who regard science as if it were, in some way, opposed to literature.

There seem to be various reasons for this attitude. In the first place, it is becoming increasingly obvious that a literary education is only half an education. It is still possible for the writing of a poem or the writing of a novel to be referred to as "the highest of human activities," but the statement is not now so generally believed. An increasing number of people are beginning to believe that the creation of a great scientific theory may be as great and significant an achievement, as high an activity, as the creation of a great work of pure literature. From this human, all too human, point of view we can quite imagine that some literary men find science a sort of rival, and a dangerous rival, to literature. But we must admit that this explanation covers only a small part of a widespread attitude. A more important element in the "opposition" to science is due to the dislike of the materialistic philosophy with which science was, until recently, supposed to be associated.

That the scientific man is a dull materialist, insensitive to beauty and incapable of profound emotions, is, or has been, a commonplace amongst literary artists. A botanist, as is well known, is a man who knows everything about a flower except that it is beautiful. That these purblind creatures have an inordinate appetite for facts, and a curious, abnormal "cleverness," is freely admitted. But since they are blind to everything that makes life to other people worth living, know nothing of the artist's raptures nor of the hopes and despairs of passionate natures, believe that nothing is real except what they can put in a test-tube, they must be treated, as Nietzsche says, as mere instruments. They are more costly and exquisite versions of their own galvanometers and spectroscopes. In the great company of prophets, seers, and poets, they have no place. They are merely measuring machines, to be made use of by their betters.

This is Nietzsche's view and it is not uncommon. Is there any justification for this view? It must be admitted that some scientific men almost warrant the caricature. It is a peculiarity of science, as distinguished from the arts, that valuable results can be achieved by mere industry. The possession of a telescope, and of an abnormal capacity for sitting still, have sometimes made their owner immortal. It is true that eminence in science can sometimes be achieved by a man without insight, without imagination, by dint of the unexciting virtue of conscientiousness. Valuable as these men are to science, they have no perceptible existence except in conjunction with a laboratory. To the literary man, for whom greatness is almost synonymous with the capacity for experiencing and expressing profound emotions, the eminent man of science may be a negligible human being—"a mere specialist." It is appropriate that such a being should adopt materialism as a philosophy. He finds nothing in his own soul which seems unlikely to be the outcome of the mutual impacts of little billiard balls, and, being unaware of his narrow limitations, he suggests that this hypothesis will cover everybody's experience. To some of the greatest literary artists of the nineteenth century, scientific materialism, as it was popularly understood, was the final proof of the inadequacy of the scientific mind. It is unfortunate that science is so technical, for it means that non-scientific people cannot distinguish between the great creator and the merely industrious worker, and that only a debased and distorted version of a scientific theory gains currency amongst them.

But while the contempt for and dislike of science manifested by such great artists as Tolstoy and Dostoevsky was largely founded on a misapprehension of what science is, the change which has occurred in the attitude of literary men towards science is certainly connected with the fact that materialism is no longer so vehemently preached by scientific men. Such great scientific theories as the electrical theory of matter and the theory of relativity have finally destroyed, it is felt, that old Victorian mechanical universe, with its "iron laws." The universe has become "enjoyable," in Maxwell's sense of that word when he says that the necessary condition of the enjoyable is that the mind

should believe in the existence of a law and yet have a mystery to move about in. In the new universe of science the poet feels that he has room to exist. Such feelings are not, perhaps, based on reason. It might be difficult to justify them, but even the man in the street feels that the "atmosphere" of the modern scientific universe is very different from that of the universe of, for example, Haeckel. For this reason there has been a change in the literary man's attitude towards science. He is even willing to admit that scientific men of Einstein's rank may, in virtue of their imagination and passion, be ranked with great artists. But although a scientific man may be ranked as an artist, there remains an essential difference between a scientific work and a work of art.

That a scientific treatise may be exceedingly well written nobody will deny. That scientific men may show a delicate and catholic taste in literature, or, indeed, in any art, is also quite true. But it does not follow that a scientific treatise, however well written, can ever rank high as a work of literature. It seems that one criterion of the greatness of a literary work is its "immortality." To achieve this it must deal with subjects of permanent interest, and its presentation of them, although it may not be exhaustive, must be of such a kind that it cannot be superseded. Even where the ostensible subject-matter is of comparatively little interest, the real subject-matter—usually the personality of the author—has this quality. Very few people are interested in the subject of urn-burial, but many are interested in Sir Thomas Browne's unique reflections on that subject. Now it is of the essence of the scientific treatise that it deals with the transitory, for it is of the essence of the scientific conception of truth that science can continually advance; and it happens that a scientific argument is not a favourable medium for the expression of the most generally interesting characteristics of an author's personality. Even the best written of scientific treatises, and written by the best scientific men, such as the Dialogues of Galileo, have no longer the living interest that much older works of literature possess.

The reason is not difficult to discover. This apparent weakness is due to the very strength of science. Science is universally communicable and verifiable, or it is not science. It makes appeal, therefore, to just those faculties and interests that are least individual in men. It is impersonal, as we say. A scientific theory is an interpretation of experience which is valid for all minds precisely because it is not concerned with experiences which are individual. A scientific man has, potentially, all rational creatures for his audience. The artist can make no such claim, but he penetrates to a greater depth. At present the greater part of every man's experience lies outside the scientific picture and, for the majority of men, is by far the most interesting part of his experience. The arguments for the belief that the sun goes round the earth, however wittily presented, are of little interest now except to psychological historians. But human nature has changed much less than scientific theories, and a presentation of unrequited love, or of goodness triumphant in adversity, can still be pertinent to present problems and has lost nothing of its illuminative power for being centuries old.

This is not to say, of course, that the deepest human passions are not concerned with science. Kepler, in describing his triumph at his discoveries, wrote some of the finest passages in literature, but those passages describe his emotions, not his discoveries. They convince us that science may require the highest and deepest emotions for its service, that a great man of science may truly be a great artist, that he may give to science a passion and creative imagination that other men give to religion. But that does not make his problems eternal, or of permanent interest. The fate of a scientific treatise, as Huxley has said, is to be part of the rubble which forms the foundation of the new building.

The distinction between the scientific treatise and the work of literature, therefore, is connected with the old question of matter and form. What Shakespeare has to convey cannot be otherwise conveyed, but a student may fully master Lagrange's conception of dynamics without having read one line of Lagrange. There is, then, an essential difference between science and art, and, however far science penetrates into regions of experience it has scarcely yet touched, there will always remain an essential difference. This does not mean that the artist can ignore science. As a matter of fact, the scientific outlook affects literature by influencing the artist's emotions. Darwin's theory, for example, has had a great influence on modern literature. The influence of science is indirect; it is an important factor in shaping the *Zeitgeist* that prevails at any given time, and so influences not only the arts, but also philosophy and religion. But there can be no opposition between science and art except in the sense that the artist may feel himself to be in rebellion against the spirit of his age, a spirit largely due to the scientific outlook current in his time, or more probably, that was current a generation or two before his. The artist, therefore, does not ignore science; the fact is, he cannot escape it. When, however, he concerns himself merely with the expression of scientific fact or theory, and not with the spirit of quest and discovery, the chords he strikes must fail to find universal response in the human heart.

World List of Scientific Periodicals.

By F. W. Clifford.

IT is difficult to conceive a publication which would be of greater value to scientific workers in Great Britain than that which is the subject of this article. Research workers in the realms of science, constantly confronted with references to periodical publications to which they have not immediate access, have often expressed the need for an authoritative list of scientific journals, together with an indication of the British libraries where they can be consulted. In the absence of this information, provincial workers are compelled to spend money and ill-spared time in journeying to and from London for serials which may perhaps be contained in a library nearer at hand.

Such a project has frequently been discussed and even commenced. The Panizzi Club, composed of senior officers of State, Universities, and Professional Libraries, got well ahead with a Union list in the early months of 1914, but the War intervened and the work so well commenced by Mr. E. W. Hulme, then Librarian of the Patent Office, came more or less to a standstill. This earlier effort was practically forgotten, when, in 1921, the need for such a list was again urgent, and the Conjoint Board of Scientific Societies appointed a small committee to devise a practical scheme for the compilation and subsequent publication of a World List of Scientific Periodicals.

The Trustees of the British Museum were approached, and recognising the importance of this work to scientific research and bibliography, they consented to allow the compilation to be undertaken by the staff of the Museum.

With this very material assistance, and financially fortified by the private guarantees of two well-known men of science, the Conjoint Board felt able to proceed with the proposal. Fortunately, at this critical period, however, the Carnegie United Kingdom Trustees expressed their willingness to add a substantial guarantee if the original scope could be somewhat widened. This action very considerably smoothed the way, and steady progress was made with the List. When the Board itself was dissolved in 1923, the original Committee was formed into a Limited Company so as to ensure the publication of the completed work.

It is intended that the List shall be issued in two parts. The first part is now in the press and will probably be published during the present year. This portion consists of a list of more than 25,000 scientific serials in existence in 1900, or originating between that date and the year 1921, whether still current or not.

Each serial is arranged alphabetically under its title, *e.g.* the Philosophical Transactions of the Royal Society will be found under "P" and not under "Academies, London." The items are numbered consecutively, and these numbers will be used in Part II. to identify the periodical. It will be recognised that in the arrangement of a list of this kind there may be several opinions as to the precise order which should be followed. The fact, however, that Prof. A. W. Pollard, until lately the Keeper of Printed Books in the British Museum, has acted as the editor, should more than guarantee that the final decision has been made in a manner which should meet with the approval of the bibliographer and fulfil the requirements of the scientific worker, whose references to periodicals are so often in a very abbreviated form.

The second part, or Index Section, will indicate in what libraries in the United Kingdom a copy of any of the serials in Part I. can be consulted. Sets of the sheets of the first part are now being circulated amongst important libraries, general and special, both in London and in specified provincial centres, for the addition of this information.

In the provincial centres the aid has been enlisted of certain professors and librarians, who are acting as local secretaries to co-ordinate the information as to periodicals taken in their respective districts. This laborious, but most valuable, work has to be carried out promptly, or otherwise the publication may be delayed. At a later date, perhaps, it may not be out of place to disclose the names of these enthusiasts, to whom scientific workers will always be indebted.

It may be well to mention that the World List is not intended to be a catalogue of the periodicals in any given library. A moment's thought will show the practical impossibility of giving all the libraries containing English journals of considerable circulation. In the case of these, the local secretaries have been asked to exercise discretion as to whether there is any need to indicate the existence of more than one complete set in their town. It would, however, be easy for any centre to use the World List as a catalogue of periodicals in that area by the simple means of stamping with a rubber stamp opposite each periodical possessed by the individual libraries comprising it. Or, as Part I. of the World List is printed on one side only, the entries could be cut and mounted on cards.

The List should also be of service in encouraging co-operation between large libraries in the direction of lessening duplication in their immediate neighbourhood, with the result that funds may be released for the purchase of additional periodicals, and in consequence increase the total number of periodicals contained in that area. At the same time such a survey would

show those responsible, how well, or ill, the research worker is catered for with regard to periodical literature in the respective institutions.

A comparison of the World List of Scientific Periodicals with the "Gesamt Zeitschriften Verzeichnis" shows that the former contains 25,000 whilst the German publication contains but 17,190. The French "Inventaire des périodiques," of which the first number has recently been issued, is not far enough advanced to ascertain the number of periodicals which will eventually be covered by it, but the letter "A" contains 2357 entries as against 2649 in the English production. No conclusion can be drawn from the latter figures, as the arrangement of the entries is not quite the same as that in the World List. Also the information as to libraries refers only to those in Paris itself.

This census of periodicals shows that the scientific journals are steadily increasing in number. Many new serials have commenced life since the War, and new Academies founded from patriotic motives are commencing to publish printed memoirs. Is it not time that a halt should be called? Would it not be possible for the older Academies to set an example by encouraging the publication of their own communications in the specialised journals? The scientific worker would then have his material more or less collected instead of contained in an academic "mixed grill." The researches would reach without delay those most interested, whilst details of abstraction, etc., would be very much simplified.

In conclusion, whilst no one library can be expected to contain all the periodicals mentioned in this monumental work, every library should at least contain a copy of the World List in order to direct inquirers to the nearest library where a particular periodical may be seen. Scientific research workers will in due time find that it is indispensable to them.

The Library Association's Subject Index.

SINCE 1915, "The Subject Index to Periodicals"[1] has been issued annually by the Library Association in the form of eight Class-Lists, except for the period 1917–19, when the lists were triennial. The Class-Lists are: A, Theology and Philosophy; B-E, Historical, Political, and Economic Sciences; F, Education and Child Welfare; G, Art and Archæology; H, Music; I, Languages and Literature (Part 1, Classical, Oriental and Primitive; Part 2, Modern and Bibliography); K, Science and Technology; L, Author Index to A-K, and List of Periodicals indexed.

The Index is a classification of articles of reference value selected from an examination of close upon 600 periodicals, English and foreign. The entries are minutely classified under the alphabetical subject headings of the Library of U.S. Congress, and are annotated where it is desirable to define with greater precision the scope of articles. The unbound numbers of periodicals sent for indexing are filed for reference and lending purposes. Any subscriber to the Index can on application obtain the loan of specified articles on payment of the return postage. Further, he can require the editors to furnish him with a list of articles under specified headings in continuation of the last printed Class-List.

Thus subscription to the Index on the part of a small rural or town library raises the status of that library to that of a research institution, for the Index places its readers in touch with the latest developments in thought, policy, and action in all departments of human life, while it maintains a library of serials for reference which is not only larger than the corresponding collections in the average municipal reference library, but probably also contains serials not to be found in the library of the British Museum itself. This work of the Library Association could not have been carried out without some external assistance. Generous pecuniary assistance has been forthcoming from the Carnegie United Kingdom Trust, while free quarters have been found for the editorial staff of the Index and its nucleus loan collection in the great National Library of Wales at Aberystwyth.

It should be noticed that "The Subject Index to Periodicals" was planned at a time when "The International Catalogue of Scientific Literature" was still in existence. Hence the Index was to a great extent designed to bridge the gaps which that publication left unfilled. With the discontinuance of "The International Catalogue," however, the question of the co-ordinated publication of indexes to scientific periodical literature once more comes to the front. This subject was brought before the Conference on Bureaux of Information and "Special" Libraries held at Hoddesdon on September 5-8. It may be taken for granted that international co-operation has failed and that the future organisation of scientific literature must be effected on a national basis.

Secondly, it should be remembered that the State has a well-defined interest in this matter, and should be called upon to shoulder its share of responsibility. For example, the principal repositories of the serial litera-

[1] Annual subscription, 4*l.* 4*s.* (Agents: Grafton and Co., 51 Great Russell Street, W.C.1.)

ture of art, education, science and technology are to be found in the State collections. In the case of many foreign serials, the only accessible copies are filed in these libraries, and naturally their curators possess the requisite qualifications for dealing with the highly specialised class of literature which they control.

Co-ordination in indexing requires the acceptance of a common scheme of classification and headings, and an agreed form of index entry. Further, the financial prospects of success under such a scheme are materially improved if the indexes produced are uniform in format and style and are published by a single agency. These conditions being granted, the actual indexing can be carried out in any home or library.

This method of indexing supplies a sound basis for development and negotiation. Any of the Library Association's Class-Lists could be split into smaller units —and some would no doubt benefit by such division, namely, B-E, historical, political, and economic sciences, and K, science and technology. A suggested inclusion of another 50 or 100 additional periodicals in any Class-List could be met if the State librarian, or secretary of the society in question, were prepared to supply the index entries and supervise or edit the extended Class-List. Any development in this direction would be welcomed by the Library Association.

The Index has now become practically self-supporting. It has been run by voluntary aid—one editor alone being in receipt of a modest salary. Finally, the Association has pledged itself not to treat any profits made by its publication as the property of the Association. Such profits will go either to a reserve fund or, more probably, towards the reduction of the price of its Class-Lists. It is scarcely necessary to add that the accounts of the Index are duly audited by a chartered accountant.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. VIII., 1923. Pp. 618. (London: Society of Chemical Industry.) 12*s.* 6*d.* net, post free.

The annual publication of these reports is not an event that evokes widespread interest or comment, yet the reports are always welcome to a goodly number of specialists. They are not original in the strict sense, because they are mainly compilations from the abstracts of original papers that have appeared during the year under review. Nevertheless they are very useful: they save the worker much valuable time; they instruct him concerning advances in branches of applied chemistry of which he has no expert knowledge; and if he believe what his testimonials state, that he has "a good all-round knowledge of chemistry," after reading these reports he will lose his conceit and confess his general ignorance.

The chief difficulty connected with publications of this kind is that the expert is too frequently a bad writer; and the chief defect is the absence of critical insight. It is, of course, no easy task to assess the value of developments that happened yesterday, but more attempts in this direction might usefully be made. Further, the reports would gain in lucidity—and the cost of publication could be materially reduced—if the phraseology were rigorously pruned; redundancy of expression and other forms of "journalese" are too common in the present volume.

A welcome feature in many of the reports is the inclusion of summaries of the trend of events in the economic sphere: a practice which should be extended, especially as there is now no single ephemeral publication which provides, regularly and systematically, information of this kind on all branches of industrial chemistry. The pending publication in the United States of *Chemical Reviews*, which will be issued quarterly and will deal with recent progress, may help to fill the gap which is now apparent in our chemical literature. If the reviews are critical and constructive as well as informative, the specialist may prefer them to annual catalogues of facts; but he will need, and should acquire, both. The comparatively small sale of annual reports of the kind we are used to is a distinct reflection upon English-speaking chemists, and no one will criticise the Society of Chemical Industry for maintaining in adverse times its expenditure on this useful publication, which falls well within the scope of its legitimate activities and of the wishes of its founders and benefactors.

Chemical Encyclopædia: A Digest of Chemistry and Chemical Industry. By C. T. Kingzett. Third edition. Pp. x+606. (London: Baillière, Tindall and Cox, 1924.) 30*s.* net.

Within the last few years several works of this character have been published under various titles. Consequently the fact that the present volume has attained a third edition within a comparatively short time shows that it has supplied a well-defined want, and indicates that a knowledge of chemistry is becoming more and more indispensable to growing sections of our population, such as merchants, brokers, barristers, financiers, manufacturers of all kinds, pharmacists and the like. Chemistry is now so intertwined with almost all walks of life that probably every educated man at some time or other has wished to know something about a substance which he has found necessary for some purpose, and it is to such a class that the present book will appeal. He will here find a brief but clear account in non-technical language of almost every chemical substance that has attained any practical importance, with some of the principal constants inserted. Even professional chemists, who have access to exhaustive treatises on chemistry, will find the book handy for rapid reference, especially as it is clearly printed and attractively bound.

Some omissions are bound to occur in a work of this kind. For example, the well-known names "Westron" and "Westrosol" do not appear, although other preparations with a similar name and composition are mentioned. It would have been advisable to have stated that the basis of these non-inflammable solvents consists of chlorinated hydrocarbons, such as tetrachlorethane, trichlorethylene, and the like.

Studies of Scientific Development.

Isis: The International Review devoted to the History of Science and Civilisation. The official organ of the History of Science Society. Edited by Dr. George Sarton. (Weissenbruch and Co., 49 rue da Poinçon, Brussels.)

A FEW months back the formation of the History of Science Society, to carry on in a more permanent form the work which Dr. Sarton has been doing at the Carnegie Institution of Washington since the War, was announced in NATURE. The first volumes issued under these new auspices have just reached us and encourage the highest hopes as to the future of the enterprise. Estimated on the lowest basis, they are extraordinarily good value for the money, a subscription of five dollars covering the whole. Those who joined for this year will have already received two volumes, counting as Parts I., II., and III. of vol. 3. The first, besides various reviews, contains a longish article by Dr. Sarton himself, explaining under the title of the "New Humanism" the objects of the new association and its organ. It is, in fact, a programme and a confession of faith by the founder. The second is a full and very careful bibliography of all the books and articles which have been approved in the second half of 1923 on the history of science and philosophy and the history of civilisation. Its classification aims specially at bringing out the interdependence of the scientific development of different countries at the same time and thus illustrates the unity of mankind and the unity of knowledge.

The third part, however, is the review proper and contains this time a large number of articles interesting alike to the specialist and the general reader. Four languages are represented among the writers, six being English, three German, one Italian, while French occurs frequently, being the natural language of the editor and forming the bulk of his article on the Irish Walton, the aquiculturist of the middle of the thirteenth century.

Among many good things one may select two other articles for special comment. Both open up a rather unfrequented line of thought in Great Britain. The first is the "bio-bibliography" of Hunáyn Ibn Ighág, the distinguished Arabian medical savant of the ninth century. This is by Dr. Giuseppe Gabrieli, the librarian of the institute in Rome for the study of Mohammedan science; it is intended to be the first of a series of such lives, which are greatly to be welcomed at the present moment when the relations between East and West are in a state of critical tension. The other article which specially attracts us is that by Prof. Lynn Thorndike, the learned author of the recent history of magic and experimental science in the middle ages. He treats in *Isis* of the history of science as it appears in the famous French Encyclopédie. He has studied the book carefully from this point of view and the results are somewhat unexpected. The encyclopedists are far less free from medieval prepossessions and errors than they thought themselves, or than posterity has supposed. They are far less violent against theology. But their strongest line was the history of industry and the mechanical arts. This was Diderot's own department, who was himself the son of a cutler. The article on the stocking knitting frame and its 2500 parts is ten times as long as that on cathedrals! When we remember that this was in 1751, before the steam engine, it would seem that we should regard Diderot as even more the prophet of the Industrial, than of the French, Revolution.

F. S. M.

Cambridge Readings in the Literature of Science: being Extracts from the Writings of Men of Science to illustrate the Development of Scientific Thought. Arranged by William Cecil Dampier Whetham, and his daughter Margaret Dampier Whetham. Pp. xi+275+8 plates. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

IN these days many young students are apt to ignore or belittle the intellectual and practical achievements of bygone generations, and any book which deals in an interesting and accurate way with the stages that form landmarks in the development of science is to be commended. In the present work the authors have shown excellent judgment in their choice of extracts from the literature of science, and the explanatory introductions they have written to the extracts add considerably to the value of the whole.

The book is divided into three sections, of which the first traces the development of men's views on the structure of the universe, beginning with Genesis and ending with Eddington on "Space, Time, and Gravitation." In the section on the atomic theory are given extracts from Lucretius, Paracelsus, Dalton, Avogadro, Mendeléeff, Faraday, Arrhenius, J. J. Thomson, Aston, Moseley, and Rutherford, all of which appear to us to be particularly well chosen. The third section, dealing with evolution, contains, *inter alia*, selections from the writings of Aristotle, Lamarck, Lyell, Pasteur, Darwin, Mendel, and T. H. Morgan; it concludes with a somewhat dogmatic passage from Bergson to the effect that thought, being a product of evolution, will therefore never be able to grasp the true meaning of the evolutionary process. Some readers may demur to the inclusion of Bergson and the exclusion of Kant; others may think that quotations from Genesis, and speculations of thinkers before the dawn of positive science, are rather out of place in an anthology of the literature of *science*; but all will agree that the work as a whole has been excellently done, and that every student of science, whether in school or university, should be encouraged to read it and re-read it.

Social Science.

(1) *The Biological Foundations of Society.* By Prof. Arthur Dendy. Pp. x+197+17 plates. (London: Constable and Co., Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Population and the Social Problem.* By J. Swinburne. Pp. 380. (London: G. Allen and Unwin, Ltd., 1924.) 15*s.* net.

THE student of social science may approach his task with either one of two objects in view. He may attempt to expose the permanent conditions upon which social evolution depends. He may, on the other hand, seek to deal with his material in much the same manner as systematists and morphologists have dealt with animals and plants. He may, in short, aim at the building up of a social morphology.

It is seldom denied that the adjective "scientific" is appropriate to studies of the first group. Under that heading falls the study, not of inheritance itself, but of the factors which are operating so as to produce changes in the germinal constitution of the race, and of factors which, given a knowledge of the conditions under which modifications are produced, can be detected in the process of impressing modifications upon each generation. Here also comes in the study of comparative psychology and the study of the manner in which the social heritage is built up, added to, passed on and lost: in other words, of the mechanism of the inheritance of tradition. The term scientific is, on the other hand, sometimes denied to studies which fall under the second heading. It is apparently held at times that they cannot be distinguished from historical studies which, by reason of the fact that they assume the form of a narrative and deal with the particular rather than with the general, are judged not to belong to science.

There are, however, grounds for distinguishing clearly between historical studies and scientific studies of social data. Not only may the latter, as also the former, be made with that detachment of outlook and accuracy in detail which characterises science, but also, in place of aiming at a narrative of particular events, they may aim at what Prof. Hobhouse calls a "descriptive synthesis." This may take the form of comparative social morphology, of the study of the trend of the evolution of an institution such as property, of an association such as the family, or of a particular civilisation. Between such studies, and those undertaken by systematists and morphologists in zoology and botany, it is hard to find any fundamental distinction, though it may be convenient to distinguish between "natural" and other sciences. The rate of progress in this field is slow, and while there may at times be grounds for the complaint raised by sociologists that their studies are not given the recognition which they deserve, it may not be out of place to remark that, if sociologists were to spend less time in discussing the scope of their science, what methods of investigation are appropriate, what the relation of sociology is to other sciences, and cognate questions, if in fact they were to get on with their task, recognition would come more quickly.

When workers in social science have firmly grounded and widely extended their studies, it may be some generations hence, a position may be reached not unlike that which faced Darwin when he surveyed the biological sciences in the middle of the last century. The systematists and morphologists had brought their studies to a point where the main outlines were clear and undisputed. It was then possible to apply to the facts so systematised what was known of the permanent conditions upon which organic life is based and to put forward a theory of evolution. So too in years to come, when enough preparatory work has been done, it may be possible to found a theory of social evolution which will show order and sequence in the data handled.

(1) The need of the time is for scientific research in both these directions. The temptation is to neglect spade work and to elaborate premature theories. It is here that Prof. Dendy's book is helpful. It may be described as a short and elementary course in general biology containing the minimum of biological knowledge that should be in the possession of all students of social science. Those who propose to pursue any branch of social science which falls under the first of the two divisions mentioned above will of course require far more detailed biological knowledge than this book can give. It will be to those whose interests and work lie in the other field that this book will be useful.

It is possible to do valuable work in systematic zoology and botany and to be almost entirely ignorant of general biology. But quite apart from the interest which a knowledge of general biology adds to these studies, such knowledge has a value in that it directs the worker's attention to many facts which he might otherwise neglect as unimportant but which, if recorded, may illuminate general biological problems. So too in studies of social data, some knowledge of general biology is not only interesting but also of great value. Had all those, for example, who have collected facts regarding existing primitive races had some grasp of biological problems, how much might they not have assisted indirectly in solving those problems by amassing data bearing upon them which, in the absence of biological knowledge, seem wholly unimportant? Or again, if attendance at a course in elementary biology was compulsory for those who are going to pursue that branch of social science known as economics, how much more definite and concrete would be their knowledge of the human material with which they deal. Prof.

Dendy's excellent little book deserves a wide audience among students of the various branches of social science.

(2) It is possible to study the population problem by attempting to lay bare the permanent conditions upon which it rests, or by collecting the facts regarding the control, density, or some other aspect of the problem under different conditions and then attempting to ascertain the trend of social development in whatever field is chosen. Mr. Swinburne's book is a disappointment in that, while written by a scientific man, it is not a scientific treatment of this problem in social science. From the book we learn what opinions Mr. Swinburne holds and what prejudices he harbours regarding most social questions of the day, including, for example, the relations between capital and labour, profit-sharing, the rights of man, government, the position of women, trade unions and socialism.

The connexion of all this with population is obscure, but those who disagree with Mr. Swinburne are asserted to hold erroneous views about population, though why they are erroneous, and what Mr. Swinburne's own views may be, are nowhere in the book logically and consistently set out. His reference to economists and their treatment of the population will serve as an example of his tone and style. "The curious point about economists' treatment of the population principle is that they never seriously discuss it or try to refute it." It is only necessary to recall that the fourth volume of the new Cambridge series of economic handbooks is wholly devoted to the population problem, and that a discussion begun by Sir William Beveridge at the Liverpool meeting of the British Association, and continued by Dr. Keynes and other well-known economists, has been occupying a very large amount of attention for more than a year in order to see the value of Mr. Swinburne's statements. All this work is entirely neglected by Mr. Swinburne. Can he have written a book of nearly 400 pages on population in ignorance of it, or, as the following quotations suggest, does he hold so low a view of the intelligence of economists that he does not read their works?

"There is no proper opening for economists, and no adequate inducement for men of first-rate ability to devote themselves to the study. The highest pinnacle an economist can reach is a professorship at some university or college. He may also write a text-book or two and there his career ends. . . . Generally speaking, an able man who can do anything else well has a strong temptation to leave political economy alone. . . . A man who might be a first-rate economist can do nearly as well in many other directions that give more return, and naturally he does so."

Whichever explanation is correct, the conclusion would seem to be that only those who are interested in Mr. Swinburne's prejudices will profit by reading his book.

A. M. C.-S.

India, and its Problems.

India: a Bird's-Eye View. By the Earl of Ronaldshay. Pp. xiii + 322 + 24 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 18*s.* net.

THE Indian Continent is such a vast agglomerate of different languages, different religions, and different peoples, not to mention varieties of climate and topography, that it is no easy matter to present it in a single view without a tendency to confuse and bewilder the reader who is not familiar with the various problems concerned. But Lord Ronaldshay is an experienced administrator who has had opportunities, on the staff of a Viceroy and later as the Governor of a great Indian province, not often enjoyed by those who have an inclination to write, and at the same time possess the pen of a ready writer. Further, he has devoted much time to the study of the history, religions, and archæology of India, in the course of which he has travelled much and has had personal experience of the scenes he describes so well. His position has necessarily brought him into contact with all that is best of modern India both in literary and political circles; so he is peculiarly well equipped to give a general sketch of the country, and in this he has acquitted himself as well as a difficult task permits.

In a chapter on "What the Buildings tell" the reader is introduced to the immense variety of architecture displayed in "the edifices raised over a vast span of time to the known and unknown gods of Indian belief," and the question is asked, Whence came the people who could produce such contrasts?

Thus we are led to the great gateways, on the North-West Frontier, in the mountain wall which hedges in and separates India from the rest of Asia, through which successive waves of invaders have passed, penetrating southward and eastward, bringing those Aryan races which have become the most numerous element. But one thing leads to another, so a description of the North-West Frontier, and its people, leads on to the ever-recurring problems connected with this troublesome corner of the Empire, especially those difficulties which have arisen owing to the no man's land existing between the British Administrative Frontier and Afghanistan. The story of our relations with the frontier tribes in recent years is told, and how, in spite of all our desires to the contrary, a forward policy has been forced upon us as the result of the climax brought about by the third Afghan War. We have now had to adopt a policy of permanent occupation in Waziristan, that is, provided the policy remains permanent, an important proviso. It may be ex-

pensive, but, probably, less so than the policy of repeated punitive expeditions, followed by withdrawal, which, under present-day conditions, requires an ever-increasing number of men to cope with the better armed, and better trained, tribesmen. Permanent occupation will go far to remove the economic causes of unrest on the Frontier, which lie at the root of most of our difficulties. We shall also be the better able to control those outside influences which have done so much harm in the past. Lord Ronaldshay's chapters on the Indian Frontier problems will do much to enlighten those who want to understand what these problems really are.

From the incursions from Central Asia the author turns to the last incursion which reached India by sea from the west. He gives a sketch of the well-known story of the rivalry among European nations, first for the possession of the trade of the East, ultimately for the possession of India itself, and the final victory of the British. As a typical example of operations in those early days he describes, in some detail, the battle of Plassey and a personal visit to the site which he made a few years ago.

In view of the present-day controversies which surround questions of the form of representative government best suited to India, all that Lord Ronaldshay has to say on the subject, in the two chapters on "Local Self-Government" and "The Indian Village," is of importance. Because we possess in a high degree the art of managing our municipal affairs by means of elective councils, it does not follow that such methods are suitable to the Indian soil. The author gives numbers of instances of failure of the elective principle. With the advent of the British, Western methods were forced on a people whose ideas of government are radically different from ours. If our methods are to succeed it will only be after a long course of instruction, and, as it were, acclimatisation. But we are not pessimistic as to the future of India, for we believe the British have an innate genius for overcoming these kind of difficulties, and finding a way out, though it may take time. One has a feeling that, on this subject, the author does not express himself as freely as he would like.

Two chapters are devoted to "Industrialism of the West" and "Wealth and Actual Potential." Like Western government, Western industrialism is distasteful to Indian ideas, and politicians have not been slow to make use of this fact. In England 80 per cent. of the population is urban, while in India 90 per cent. is rural, engaged in agricultural and pastoral pursuits. As a rule the Indian does not take kindly to factory life in the great industrial centres—his thoughts are in his village, to which he returns at the first opportunity. His heart is not in his occupation, and he often makes an inefficient workman. As a consequence, though wages are lower, a larger number of men are employed to produce a given article than in Europe, which often results in the Indian production being more costly than that which could be imported. The Indian politician, even Mr. Gandhi himself, though inveighing against modern innovations, is not above making use of railways and motor cars. Gandhi has made a dead set against European medicine, "which has been singled out for special attack," but by a curious irony he has recently undergone a serious operation at the hands of a skilful English surgeon who saved his life. One cannot help thinking this antagonistic attitude towards industrialism has more of a political motive than anything else, certainly among the extremists, merely because of its Western origin. In India one often hears the development of Japan applauded as an example of what an Eastern people is capable of achieving.

British future commercial relations with India must be free from the suspicion that we have any desire to exploit her. The author puts this point very well when he says: "It must be for the good of India that her wealth should be increased, and since outside aid is necessary to this end, what has to be done is to make it clear to India that the aid which Great Britain can offer her is given to the mutual advantage of the two countries, that if British business men look to receive a reasonable return themselves, they have no desire to deprive her of a reasonable share of the total profit. In other words, what they desire to do is not to exploit her to her disadvantage, but to co-operate with her in a business of mutual benefit."

Popular Hinduism is dealt with in a chapter describing some of those great religious festivals which play such an important part in Indian life, many of which the author has personally witnessed. When one considers the original meaning, and sublime conceptions, which have been read into some of these ceremonies, one is astonished at the wide departure from the original one sees to-day. It is not difficult to imagine the sceptic asking whether poets and thinkers in trying to explain away, by dint of allegorical interpretation, certain ceremonies, are not making ingenious attempts, though perhaps unconsciously, to put a fair complexion on practices which are not in accordance with modern ideas.

The concluding portions of the book endeavour to explain the reasons for the pessimistic outlook on life which apparently pervades the majority of Indians. This is attributed, partly to climatic and physical surroundings, which have enervated and saturated the people with malaria, and partly to the hopeless

religious doctrine of *Karma*, which lands those who believe in it in a tangled maze. The consequence of this doctrine, to the believer, is that "all existence in this world is suffering and sorrow"; the Hindu's ambition is not to prolong it but to escape from it. In these circumstances how can life be anything but a joyless existence? We are told of the measures which have been, and are being, taken to combat the evil of malaria, a most difficult matter when such a large area is concerned. These are based on the discoveries of Sir Ronald Ross and others, and are being carried out on a large scale, with ultimate benefit to the people.

Lord Ronaldshay always wants to get to the origin of things, and this adds enormously to the interest of what he has to say. Some of his pen pictures are delightful, as where he describes dawn on the Frontier; they vividly recall the scenes with which the Anglo-Indian is familiar.

It has not been possible to do more than touch on some of the topics with which this book deals. We thoroughly recommend it to all who would know about India; it is written in a pleasant style and is the result of much study and experience acquired on the spot. The reader will find something of interest on almost every page. H. L. C.

The Ascent of Man.

Making of Man: a Study in Evolution. By Sir Oliver Lodge. Pp. 185. (London: Hodder and Stoughton, Ltd., 1924.) 3*s.* 6*d.* net.

SIR OLIVER LODGE is unique among our men of science in commanding public attention on general and religious questions, as well as on the branch of science which he has made his own. Hence the little book before us will have a large audience, rather for its qualities of inspiration and feeling than for any definite contribution to its special subject. For on the biological side it is extremely scanty, and compares curiously in this respect with the volume of somewhat similar size and title from Prof. J. Arthur Thomson which we noticed a few months ago. The latter was from the pen of a biologist, this of a physicist, who has adopted with passionate conviction some highly speculative theories on psychical phenomena. But the book shows how perfectly Sir Oliver has learnt to use his great power of clear and simple exposition in the service of the religious propaganda which has now become the main interest of his life. The language is always effective and moving, though the sentiments are often obvious enough, and where he draws on his own province of physics, the illustrations are extraordinarily apt and sometimes beautiful. The concluding analogy of the Sun and the Divine is one of the best things of the kind we have ever seen.

But it is only fair to point out to intending readers that they must not expect a scientific treatise. For the shortest summary of the biological or sociological evolution of man, they must look elsewhere, *e.g.* to the little book by Prof. J. Arthur Thomson. Here we have rather a series of sermonettes, variations on the theme that the human spirit is an emanation of the Divine, that we may trace in its history clear evidence of an upward movement, that this movement is the result of continued effort, and that we can only attain a belief in "rational optimism," in the divine governance of the world for good, by seeing in this "effort" the necessary condition of any movement. It is here that Sir Oliver's physical analogies are most to the point. He shows in an early chapter how all change in movement involves force, and how all force implies resistance. This leads to the argument that evil is, philosophically considered, only the reaction implied in action. Things are not "done easily by nod, even by the Deity."

As the book thus becomes within its limits rather a philosophical, religious treatise than a scientific work, one would like to see some of these philosophical conceptions more deeply penetrated. But even this sense of insufficiency does not prevent a real outburst of gratitude and admiration for the veteran thinker and writer, who thus in the evening of his life puts forth such an inspiring exposition of his beliefs on the deepest personal questions which move us all; and, though he shows his own convictions on psychical phenomena by frequent reference to "the other side," he does not allow this prepossession to disturb the general argument. Men of all views, in fact, can find something to their advantage in the "Making of Man."

F. S. MARVIN.

Prehistoric Times.

Ancient Hunters and their Modern Representatives. By Prof. W. J. Sollas. Third edition. Pp. xxxvi+697. (London: Macmillan and Co., Ltd., 1924.) 25*s.* net.

IT is nine years since the second edition of Prof. Sollas's "Ancient Hunters" appeared. The present book, although substantially the same in structure as the last, has been revised and brought up-to-date. New matter has been added involving the lengthening of the work by more than a hundred pages and the addition of several illustrations. In a rapidly developing subject like prehistory it is impossible to say that the last word has been written, but it can safely be prophesied that, in this revised and up-to-date form, "Ancient Hunters" will be for many

years to come an essential feature on every specialist's bookshelf, and will remain the best book to recommend to the thoughtful non-specialist reader interested in the subject.

As in the previous editions, the work opens with two chapters on quaternary geology and the antiquity of man. There follows a discussion of the thorny eolithic problem, where Prof. Sollas very judiciously sits on the fence, and next a description of the various Palæolithic cultures (here, perhaps, the specialist will regret the omission of the term Middle Palæolithic for Mousterian) interdigitated with accounts of what Prof. Sollas considers to be their modern counterparts—the Tasmanians, Australians, Bushmen, and Eskimos. The book concludes with a résumé of our knowledge of the chronology of Palæolithic times.

As regards the chapters on modern primitive peoples, while these are very illuminating to the specialist, perhaps a word of warning may be forgiven for the sake of the casual reader. Similar climatic conditions do no doubt produce a certain similarity of cultures when acting on more or less automatic humanity, but this must not be carried too far. Similar flint implements do not postulate similar ceremonies and modes of life. In the case of the Tasmanians and Australians, it seems positively dangerous to link those cultures in any way with that of early Palæolithic man in Europe, merely on the strength of there being a certain similarity in their stone tools. Although Mousterian culture apparently occurs in quaternary deposits in northern China, linked to that of western Europe by finds in southern Siberia and eastern Europe, it is a far cry from the prehistoric industries of northern China to those of the more or less modern inhabitants of Australasia. The same may be said of the Eskimos, though in this case a similarity in skull form has been adduced. With the Bushmen of South Africa, however, we are on safer ground. Not only are the tools similar but also the art—a much more conclusive criterion—is in some cases almost identical; compare the finds at the Barranco de Valltorta in east Spain with some of the Bushmen paintings—the technique is the same. Again, the Bushmen have a legend that they came from the north, and therefore probably from the same stock which supplied Neoanthropic man to western Europe.

In conclusion, one can have nothing but praise for this excellent third edition, the popularity of the predecessors of which has borne testimony to its worth. Prof. Sollas writes from first-hand information, having taken the trouble to visit personally the sites of discoveries so new that they had to be put in an addendum note at the beginning of the book. It is an open secret, that on receipt of a chance card, he posted without pause to the south of France and waded up to his waist in ice-cold water to see these new finds at Montespan. May this fascinatingly readable book, readable though information or material is never sacrificed to make it so, have the great success it undoubtedly deserves. M. C. B.

The Problem of Atlantis. By Lewis Spence. Pp. xi + 232 + 16 plates. (London: W. Rider and Son, Ltd., 1924.) 10*s.* 6*d.* net.

THE Atlantis problem affects so many departments of scientific inquiry that it is always with us. Mr. Lewis Spence, author of a series of books on the folk-lore of America and Egypt, is an enthusiastic champion of the existence of Atlantis, and of the historic importance of the Atlanteans. In this volume he conveniently collects the classical traditions on the subject and evidence from geology, biological distribution, archæology, and folk-lore, of a former connexion between Central America and the Mediterranean region by a transatlantic land.

There is much geological and biological evidence in favour of the existence of this land in the early and middle Kainozoic—a period, however, long before the age of man; but it gives no direct proof of large islands in the mid-Atlantic at the time required by the Atlantis theory. The direct land connexion between southern Europe and the opposite coasts of America must have been broken at the end of the Miocene; but there may have been surviving islands which have gradually foundered, just as Malta is a fragment of a land that once connected North Africa and Sicily, and has been reduced in size by repeated subsidences. If the rest were submerged, some ingenious critic might claim that the reports of Malta and its Phœnician population and its Knights of St. John were all an allegorical myth; and neither the geologist nor the biologist could refute him.

Atlantis may have been the remnant of a mid-Atlantic land which was inhabited by a cultured race that sent colonies into both the Old World and the New. The author claims that the Cro-Magnon race came from Atlantis and entered Europe from the west—a conclusion which would remove some difficulties. The direct evidence of the survival of Atlantis into the human period depends on the archæological evidence. Mr. Spence shows that the amount in common between Central America and Peru and the Mediterranean region is far more than can be explained by coincidence. He agrees, therefore, with Prof. Elliot Smith that the cultures of Egypt and tropical America were indebted to the same source; but he rejects the view that the connexion was established across the Pacific, owing to the absence of evidence of the Asiatic influences that should have been engrafted on the culture if it had passed from Egypt to America by

an eastward route. Mr. Spence recognises that the people of south-eastern Asia influenced those of tropical America; but he regards this connexion as independent.

The author is indiscriminate in his acceptance of anything that appears to support his views. Many of his arguments are unconvincing, such as the identity of the names Cleito with Coatlicue and of Atlas with Uitzilopochtli. He also accepts newspaper statements, which, though often useful as a clue, are not scientific evidence. Thus he remarks that the discovery in August of last year of a 2¼ mile rise in the floor of the South Atlantic in the course of the previous twenty-five years should make "the scoffer" revise his belief in the stability of the ocean beds; but the author's acceptance of this "mare's nest" may tend to make his readers scoff at a theory which accepts such statements without troubling to confirm them or even awaiting their contradiction.

L'Homme préhistorique dans l'Europe centrale: *Primeval Man in Central Europe*. By Prof. Dr. P. Goessler. Pp. 134 + 40 plates. (Stuttgart: Franckh'sche Verlagshandlung, 1924.) n.p.

In this volume Prof. Goessler, Director of the State Museum of Antiquities in Stuttgart, has published a series of forty plates with descriptive letterpress, each dealing with a type of prehistoric man or of prehistoric culture, the type skull being figured with characteristic associated implements, ornaments, etc. The series begins with Heidelberg man and ends with the races of Central Europe of the present day. Students will appreciate the special attention which is given to the archæology of south-east Germany. The author has not, however, confined himself to Central Europe, and in the palæolithic age in particular the skeletal remains of early man from France and Britain as well as Rhodesian man are duly noted; but Piltdown man obtains no more than an incidental mention in connexion with the Galley Hill skull. In later periods, especially the bronze and iron ages, while the place of origin of German finds is, for the most part, carefully noted, in the case of many of the objects figured from other sources, this information is not given at all or only vaguely. The text is in German, French, and English, but the last-named is so bad as to be unintelligible at times without the original German, and shows almost complete ignorance of English technical nomenclature.

Man before History: *a Short Account of Prehistoric Times*. By Mary E. Boyle. Pp. 128 + 8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 2*s*.

Of the total number of pages in Miss Boyle's little book, one hundred deal with the palæolithic period proper. The remaining 28 pages cover the Azilian, the Neolithic, the lake villages, the arts and crafts of the neolithic age, and the beginning of writing. This may seem a little out of proportion, but as her book is written for young people, her scale of treatment may be regarded as justifiable, especially as in this comparatively restricted space she has been able to indicate, at any rate in outline, the more prominent characteristics of the culture of the later period. She has wisely paid particular attention to the art of prehistoric man. Indeed, there is no book of this size and type which contains so many excellent reproductions of the cave paintings and the carvings as have been given by Miss Boyle. The later and less well-known art of Spain also receives due attention. Miss Boyle tells her story in a straightforward manner which is very much to the point. Within its limits this is an admirable little book and one of the best of its kind.

The Evolution of Man: Essays. By Dr. G. Elliot Smith. Pp. viii + 159. (London: Oxford University Press, 1924.) 8*s*. 6*d*. net.

In this volume Prof. Elliot Smith has reprinted three addresses—his presidential address to Section H at the Dundee meeting of the British Association in 1912, a paper presented to the British Academy in 1916, and a lecture delivered at the Royal Institution in the current year. Each deals with some one aspect of man's evolution, with particular reference to the specifically human attributes which evolve *pari passu* with the development of the brain. To them he has added a foreword in which he demonstrates with diagrams a tentative scheme of the relationships of the different genera, species, and races of the human family and a similar scheme of the relationship of the order of primates. In the former of these he puts forward what are undoubtedly very suggestive views on the problems presented by Eoanthropus and Rhodesian man. Prof. Elliot Smith has republished these lectures to meet the need for a consistent and coherent account of the essential factors in the evolution of man, pending the preparation of a more elaborate text-book, which, it is needless to say, will be heartily welcomed by all who are interested in this subject.

Origins in Place Names. By An Ignorant Student. VI.: *Life*. Pp. 7. (London: Privately printed at the Chiswick Press, 1924.) n.p.

Although numbered the sixth in the series, this is the fourth in order of publication of the pamphlets in which "An Ignorant Student" discusses the origin of place-names from various aspects. In this case his object is to link up place-names with the order of universal law by showing that they evolve logically from a conception of life as functional and the result of an arrangement and grouping of individual units. Just as from the leaf of a tree certain deductions can be drawn, it is possible to deduce from language, which is an expression of life, the country in which it grew and, on careful analysis, to arrive at the elements of which it is composed. The author's conclusion, therefore, is that among the earliest forms of language were the words, which we now call place-names, describing and locating the homes of the people who used them. This, if somewhat obvious, is no doubt true, provided a reservation is made in favour of the priority of certain other classes of words dealing with the personality and primary needs, such as food.

The Galapagos Archipelago.

Galápagos: World's End. By William Beebe. (Published under the auspices of the New York Zoological Society.) Pp. xxi+443+65 plates (9 coloured). (New York and London: G. P. Putnam's Sons, 1924.) 42*s.* net.

THE Galapagos Islands are situated directly on the equator, about 500 miles distant from Ecuador, which claims their sovereignty. They are volcanic islands, arising precipitously from a bank at 2000 metres, and their topographical connexion is with Costa Rica and Panama, 650 miles distant, with the tiny Cocos island between. They number 13 larger islands with numerous coastal islets, the largest island (Albemarle) more than 70 miles long, and they were formerly described as having 2000 craters. They are all volcanic, and every few years there are outbursts in one or other of them. Unfortunately they have no water, except what accumulates in pools in a short rainy season, so that the vegetation is relatively scant, except in selected spots, without that accumulation of broken-down rock and plant remains, which forms the rich soil of most tropical islands. Their shores are rocky in the extreme with cliffs and great boulders, and small inlets here and there, the sort of shore one is accustomed to expect on oceanic islands formed by submarine volcanic activity after the ash is washed away and the lava laid bare. Their surface is jagged rock with bushes and cacti in the crevices, so inexpressibly uncomfortable and thirsty that the interior of the larger islands would seem never to have been explored.

"A land pitted by countless craters and heaped into a myriad mounds of fragmentary rock; gnarled trees bleached by salt spray, with twisted, stunted branches; grotesque cactus stiffly outlined against black lava boulders . . ."

First the scene of the legendary adventure of an Inca king, then in 1535 explored for spices and gold by a Spanish bishop, later for almost 200 years the refitting station of buccaneers and whalers in succession, the Galapagos may now be described as almost a holiday resort for scientific expeditions. Chatham Island alone was inhabited as a penal and cattle station, the others almost untouched save for the ravages of pigs, goats, cattle, donkeys, and dogs on different islands. Dampier, that great exploring buccaneer, Porter, a raider on peaceful whalers, Darwin, a young ship's surgeon of twenty-six, and others, described them in terms which are generally correct to-day, so small are the changes produced by man.

The Californian Academy of Sciences, in an expedition under R. H. Beck in 1905, collected for almost a year and secured specimens of all sorts in such vast numbers that further collecting would seem unnecessary. However, in 1923 the New York Zoological Society adventured through one of its patrons, Harrison Williams, who took a party on board his yacht for a three weeks' cruise there. Beebe, one of the soundest of the United States naturalists and a most enthusiastic observer, was in charge, having W. M. Wheeler as entomologist and a party of twelve more including curators, artist, photographers, historian, preparateur, physician, and taxidermist. The object was clearly to get living animals for the Society, exhibition specimens for the Museum of Natural History at New York, and films and photographs of wild beasts, that still have no fear of man, for the general public. It was simply a scientific reconnaissance, extraordinary only in the quality and completeness of its personnel and equipment, and in these respects it may be described as "the last word." The immediate result is a readable book by Beebe, full of interesting observations, while Osborn contributes as florid an introduction, "In the Wake of Darwin," as we ever remember to have seen outside journalese, describing the expedition as "among the scientific wonders of our century"; "It is like rubbing the Aladdin's lamp of science," etc., terms which we would ourselves prefer to apply rather to the wonderful series of American palæontological results to which that author has himself been such an inspiring contributor.

Space permits reference to only a few of the natural history observations. We particularly like the accounts of the sea iguanas, up to 4 feet in length, in their vast numbers on suitable rocks, swimming by their flattened tails with hanging-down legs by which they cling for browsing on the seaweeds in the foam of the breaking waves and by which they drag themselves on land; the description of a crab crawling over one and picking off its ticks would not be believed if described by any other observer than Beebe. The mocking birds (Nesomimus), their habits and distribution, are scientifically interesting, once continental visitors, now perhaps species in the making in the different islets. A small penguin occurs, the only example north of the equator, and then there is the flightless cormorant, a bird one third longer with its wings 40 per cent. shorter than its nearest allies, as wonderful in many ways as the classic great auk, and like it, assuredly, doomed to disappear.

The huge southern sea-lions were generally so tame that the naturalists could approach and pick up their babies at will, their chief foes and those of the seals being rather of the water than of the land. Buccaneers and whalers came to the islands largely for the giant land tortoises, and the Californian Academy Expedition collected more than 250 specimens in which they recognised 15 species, separated from one another chiefly

on shape, with no real structural differences. They are known from 11 islands, each of which had one race, with the exception of Albemarle, which had several. All the evidence points to no interchange of tortoises between the islands, and the problem here, as in the Mascarene islands, is the method of their arrival, the evidence of any continuous land mass for their transport being equally small. Beebe only took one, and that from the bottom of a crater on Duncan Island; he found that it swam well and intelligently, this being against his views as to the necessity of a former land connexion with Costa Rica to explain the flora and fauna now existing in the Galapagos. At Albemarle they used to occur on the highest mountains, where there is much rank grass. A Guayaquil farmer started here a ranch to round up the cattle for their hides while the old tortoises were killed for their oil, few young, if any, surviving the depredations of the dogs. Whether any still exist in Albemarle is doubtful, and anyhow, unless there is some reservation, they will soon be known only as beasts of a past age. This is the fate which has befallen the land iguana on most islands, but Beebe found them still numerous in South Seymour. These lizards attained a length of 50 inches and live inland in holes which they scratch in the ground. They are vegetable feeders, their epicures selecting buttercup flowers and their gluttons cactus fruits and leaves with their spines and all, the former shaken down like apples from a tree. In fighting, unlike most large lizards, they use their jaws rather than lateral swishing movements of their bodies.

There is much else in Beebe's book to which we would like to refer: the finding of six bleached skeletons of the rare killer whale (Pseudorca), the capture of a species of Branchipus, many notes on the habits of birds, insects, and crabs, and a whole chapter on the life in rock pools. The impression we have gained is that, while there is no use for any more exploring expeditions, the Galapagos is still an immense field for the naturalist in the study of the mode of life and of the life histories of all the more lowly land forms. In particular, from a species point of view, the insects scarcely seem to have been touched, and a collector of the type of Perkins or Scott might find as rich a fauna as these two found respectively in Hawaii and Seychelles. We suggest to the New York Zoological Society that all speculation as to the origin of the Galapagos fauna is vain in the absence of such an intensive study, and that the outcome of their reconnaissance should be a determined attack directed to this end, before the islands are altered still more by the animals man has introduced. This, we conceive, is what the progress of biological science demands from them.

J. Stanley Gardiner.

Animate Nature.

Animal Studies. By James A. Todd. (Foundations of Nature Study Series.) Pp. 135. (Edinburgh: A. Baxendine and Sons, 1924.) 2*s.* 6*d.* net.

With the best intentions in the world it is impossible to give an adequate summary of the animal kingdom in ninety small pages of print, and the author of this little book has attempted too much in the space allowed him. The book has been published mainly to obviate the so-called waste of time involved in note-taking by students. The author's own lectures must of necessity have been fuller than the very imperfect summary given here would indicate, and judicious notes taken by the students themselves at the time would have been infinitely more useful to them. The book is an example of that tendency to excessive spoonfeeding which is so much to be deprecated in modern educational methods, and can serve no really useful purpose. The illustrations are poor and in many cases unrecognisable. We have not detected many actual errors of fact, but Asellus is not found on the seashore, and the generic name of the blow-fly is incorrectly given.

Vivarium and Aquarium Keeping for Amateurs: a Practical Guide to the Hobby. By A. E. Hodge. Pp. 128+6 plates. (London: H. F. and G. Witherby, 1924.) 5*s.* net.

As the author justly remarks, the construction of vivaria and aquaria is mainly a matter of common sense and ingenuity, based on an adequate knowledge of the habits of the animals to be kept in them. Mr. Hodge is, therefore, content to lay down a few guiding principles and to devote the main part of the book to those special requirements of food and environment peculiar to individual species, the knowledge of which is only gained by experience. In this respect the book is most valuable, and the author's hints and practical advice will save the beginner many an anxious hour and many an unnecessary loss. Attention is confined to reptiles, batrachians, and fishes, with special reference to the British species, and only to those which require no heating apparatus. The book makes a timely appearance in view of the opening of the new aquarium at the London Zoo, and should do much to popularise a fascinating hobby.

Deer-stalking in Scotland. By Alexander Inkson McConnochie. Pp. 208+8 plates. (London: H. F. and G. Witherby, 1924.) 10*s.* 6*d.* net.

The author has here collected together a series of memories and adventures among the deer forests of Scotland, contributed by enthusiastic devotees of the sport of deer-stalking, and a goodly number of stalking yarns wherewith to beguile the autumn evenings after a good day on the moors. The book is essentially written for the sportsman rather than the naturalist. The chronicle is well and racily told, and will appeal to all those who have experienced the thrill of the hunt. The Duke of Atholl contributes a preface, in which he touches briefly on the much-disputed question of the economics of deer forests.

Thermionic Valves and Radio Communication.

The Thermionic Valve and its Developments in Radio-Telegraphy and Telephony. By Prof. J. A. Fleming. Second edition, fully revised. Pp. xiii + 438. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

So rapid have been the advances made in radiotelegraphy and radiotelephony that the author has found it necessary to rewrite much of the first edition of this useful book. The invention of the two-electrode thermionic valve by Prof. Fleming in 1904 made an entirely new departure in the radio art. The subsequent development of the hard three-electrode valve marks an equally important advance. With the exception of the crystal detector, all other types of detector for electric waves have now been made antiquated. As a generator of electric oscillations the valve has come to the front. As a relay or repeater in telephony also it is being very widely used. The author has added a new chapter on thermionic relays. A telephone line filter is described, and a clear account is given of carrier wave telephony applied to ordinary telephone lines. Speech has been transmitted perfectly from the Atlantic to the Pacific Ocean. It first passed by radio thirty miles over the sea, then 4000 miles overland by wire, and finally it passed thirty miles over sea again by radio. All the transmissions were effected by thermionic valves, no human agency being employed.

Thermionic Tubes in Radio Telegraphy and Telephony. By John Scott-Taggart. Second edition. Pp. xxiv + 470. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

THE thermionic valve has come into almost universal use for radio-communication. This volume describes the development of this valve and gives many of its applications. The author has considerable practical experience of valves and has made a judicious selection from the leading papers and the more important patents on the subject. If he errs at all, it is in making the book too comprehensive and going too much into detail. A beginner reading this book almost wants some one to point out what to read and what to omit, at least, on a first reading. Very properly the author begins by describing the phenomena in terms of modern theory. But we are afraid that our imagination fails to grasp what is meant by saying that there are about 10^{22} free electrons in a cubic centimetre of cold metal. Current is taken as flowing from points of high negative potential to points of low negative potential. Modern theory certainly explains very satisfactorily the working of the three-electrode thermionic valve. We can recommend this book to serious students of the subject.

Wireless Possibilities. By Prof. A. M. Low. Pp. 77. (London: Kegan Paul and Co., Ltd., 1924.) 2*s.* 6*d.* net.

IT is useful occasionally to try to unravel the future. This is usually left to poets. The author of this little book, however, encouraged doubtless by the marvellous linking up of the whole world by radio-communication, has ventured to indicate some of the lines along which future developments will probably take place. Incidentally the reader learns many useful scientific facts. Radio television has almost been realised. Why not methods of preventing local thunderstorms and of improving the growth of wheat or of young animals? Radio waves may affect our health. Why should we not try to render this effect beneficial? The days of the outside aerial are limited. The study of radioactive materials may in one day produce the cold-emitter valve. It is difficult to believe that we are not on the eve of great scientific developments.

Forthcoming Books of Science.

Agriculture, Forestry, and Horticulture.

Ernest Benn, Ltd.—Varieties of Cultivated Oats, H. Hunter; Agricultural Progress: The Year Book of the Agricultural Education Association, 1925; "The Fruit Grower" Directory and Handbook, 1925; Cut Flowers for Market, F. J. Fletcher. *A. and C. Black, Ltd.*—Gardens of South Africa, Dorothea Fairbridge, with 16 page illustrations in colour from pictures by Elizabeth Drake and others. *Cambridge University Press.*—Farm Accounts, C. S. Orwin, new edition. *Central News Agency, Ltd. (Johannesburg).*—Cotton in South Africa, W. H. Scherffius and J. du P. Oosthuizen (S.A. Agricultural Series, Vol. III.). *Chapman and Hall, Ltd.*—Principles of Dairying, Judkins. *Hutchinson and Co.*—The Culture of Bulbs, Bulbous Plants, and Tubers Made Plain, Sir J. L. Cotter, Bart. *Longmans and Co.*—My Garden Book, J. Weathers; Every-day Life on an Old Highland Farm, 1769–1782, I. F. Grant, with a Preface by Prof. W. R. Scott. *G. Routledge and Sons, Ltd.*—Practical Forestry, from a Workman's Point of View, A. C. Drummie.

Anthropology and Archæology.

D. Appleton and Co.—Human Origins: A Manual of Prehistory, Dr. G. G. MacCurdy, 2 vols. *Cambridge University Press.*—The Races of Man and their Distribution, Dr. A. C. Haddon; The Social and Political Systems of Central Polynesia, R. W. Williamson, 3 vols.; The Origin of the English Nation, Prof. H. M. Chadwick, reprint; The Medieval Village, G. G. Coulton. *John Lane, the Bodley Head, Ltd.*—Our Prehistoric Forerunners, C. E. Vulliamy. *Longmans and Co.*—Great Peoples of the Ancient World, Dorothy M. Vaughan. *Macmillan and Co., Ltd.*—The Belief in Immortality and the Worship of the Dead, Sir J. G. Frazer, Vol. III.: The Belief among the Micronesians; Ritual and Belief in Morocco, Dr. E. Westermarck, 2 vols.; Leaves from "The Golden Bough," culled by Lady Frazer; Men and Thought in Ancient India, Prof. Radhakumud Mookerji. *Methuen and Co., Ltd.*—Primitive Law, E. S. Hartland; Primitive Labour, L. H. Dudley Buxton; Folk-lore Studies: Ancient and Modern, Prof. W. Halliday. *G. Routledge and Sons, Ltd.*—Social Organisation, Dr. W. H. R. Rivers, edited by W. J. Perry; The Earth before History, E. Perrier; Prehistoric Man, J. de Morgan; A Thousand Years of the Tartars, Prof. E. H. Parker; The Threshold of the Pacific, Dr. C. E. Fox, edited by Prof. G. Elliot Smith; London Life in the XVIIIth Century, M. Dorothy George; Language: a Linguistic Introduction to History, Prof. J. Vendryes: A Geographical Introduction to History, Prof. L. Febvre. (History of Civilisation.) *Seeley, Service and Co., Ltd.*—Arabs in Tent and Town, A. Goodrich-Freer (Mrs. H. H. Spoer); In the Nicobar Islands, G. Whitehead, with a Preface by Sir R. C. Temple, Bart.; Pygmies and Bushmen of the Kalahari, S. S. Dornan.

Biology.

D. Appleton and Co.—Evolution, V. Kellogg; Race Hygiene and Heredity, Dr. H. W. Siemens, translated by Dr. L. F. Barker; The Criminal as a Human Being, G. S. Dougherty; Fishes, Dr. D. S. Jordan, new edition.

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