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The Ministry of Health.

TRUE versatility is a very wonderful thing, a fit object for the admiration of crowds. History, which is life, offers few examples of true versatility, but what history omits Shakespeare supplies and modern governments assume. Thus the Henry of poetry:

> Never was such a sudden scholar made. . . . Turn him to any cause of policy, The Gordian knot of it he will unloose, Familiar as his garter.

In modern governments, too, abstrusest specialisms must be presumed to grow "like the summer grass, fastest by night." Although Sir William Joynson-Hicks had already held three governmental positions within a year, it may not have been the poetical parallel that has just led to his appointment as Minister of Health; it may have been the old, outworn, Platonic view of the abilities, or absence of them, essential to a statesman; or even mere political exigency. Of one thing we are sure, that the development of a young but vitally important Ministry has been delayed, we hope only temporarily, by the appointment. If a surgeon should ever be offered the woolsack, there is not a lawyer but would deem his previous courses to have been very vain indeed; but to bestow the title of Minister of Health upon a layman evokes singularly little comment. We must be richer than we imagine we are in political genius if the solution of such problems as the inception of an administration of state medicine can be taken up, in a social organisation of such magnitude and complexity as our own, at the rate of four a year. But there is, to the public view, an appearance of difference between the legal and the medical cases, which must be examined and understood before we can proceed intelligently towards an improved condition of affairs.

This aspect of the matter has never been analysed more shrewdly than by Sir Lenthal Cheatle, who, so long ago as last January, set forth to defend the Ministry of Health from the Ministers in the *Nineteenth Century and After*. In his balanced and moderate exposition there is not a loophole left for political control of the office, because the sole reason for political control is objection to medical control, and of such objection nothing survives Sir Lenthal Cheatle's examination. He realises that Dr. Addison's appointment—a purely political appointment, by the way—did not prove, in the opinion of many people, to be a good one. There have been lawyers who have held the Lord Chancellorship and failed in it, lawyers who have held the Premiership and come to grief, lawyers who have held the Irish Secretaryship and brought grief to others; but it is still considered right and proper to appoint a lawyer Solicitor-General, although of Solicitors-General some

have been better than others. Sir Lenthal Cheatle realises that a man can be a good Minister of Health and a bad political tub-thumper, or a great doctor and a bad Minister of Health. He realises that the members of the medical profession actually in the House of Commons, and available for so great a post, are very limited in number, and that occasions may arise when the kind of man wanted would have no seat. Most of the medical members of the present Parliament are there because, first or last, they are politicians, and between them they represent every party opinion in the House. They are not there because politics is the high road to professional advancement. It is not. It is a hobby for medical men who are also men of leisure, the politically minded representatives of politically minded constituencies, who, happily, bring into the deliberations of Parliament, nevertheless, a wealth of special knowledge valuable to the community.

We fail to see in any one of these circumstances an irremediable defect in medical representation or an insuperable barrier to the appointment of a Minister able to direct the first steps of the nation along the pathway to a socially organised health and fitness. But that path is not one of forensic argument. It is one of vision and discovery, possible only to him whose mind is well prepared for the germination of the creative idea by long and close familiarity with the discipline of his science at first hand. Nor must he be sunk beneath the weight of problems of policy and administration foreign to his office, or deprived of jurisdiction essential to its unity. Sir Lenthal Cheatle is right in asserting that the truth, dignity, and force of the public utterances of such an office would themselves advance the cause of health and instruct and benefit mankind. The requisite ability is one that is typically British, exemplified in every department of our Colonial administration, and particularly in the rise of the science of tropical medicine, which is state medicine, under the guidance of British workers.

Possibly it is true that the medical profession itself, having arrived at a clear perception of its functions in modern social life, has not realised how it can make them properly effective. But this opens up questions of great complexity concerning professional and public psychology, both separately and in relation to each other. The pendulum of popular opinion concerning medical men swings from excess to excess through ignorance. In moments of personal thankfulness a doctor is a saint; in moments of collective contemplation he is sometimes worse, but never better than a wordy fool. The people have invented proverbs about doctors, as they have invented proverbs about everything they distrust: proverbs about their differing and about their mistakes. But let a man go to his doctor, or his doctor come to him—a sort of reconciliation occurs. It is a wider thing than it looks, for at heart it is a reconciliation between life and science. The burden of achieving that same reconciliation in politics must fall mainly on the shoulders of the medical profession. Its members we should describe at present as inarticulate rather than dumb, for the medical profession is, after all, a thing of vast subdivisions. Medical science and the profession are not interchangeable terms, and the battle is not the doctors' alone, but theirs for science and the advancement of social life.

Time lived and Time represented.

Durée et simultanéité : à propos de la théorie d'Einstein. Par Henri Bergson. (Bibliothèque de Philosophie contemporaine.) Deuxième édition, augmentée. Pp. x+289. (Paris : Félix Alcan, 1923.) 8 francs net.

WHEN M. Bergson published the original edition of this book last year, he refused to allow its translation because he regarded the work as tentative. It was the result of a special study, which had required a setting aside of purely philosophical research in order to concentrate on mathematical problems. The effect of his intervention in the relativist controversy, which he recognised to be vital in its bearing on the future of mathematics and metaphysics, could not be foreseen. He has now published a second edition, and while he has not found it necessary to revise or alter or modify the first, he has added three appendices, which not only greatly enhance the value, but also enable him in a most striking way to reconcile, and bring into harmony, his theory of time as fundamental reality, l'étoffe même de l'univers (" il n'y a pas d'étoffe plus résistante ni plus substantielle "), with the principle of relativity, according to which time is a variable coefficient, entering with variable spatial coefficients into infinite systems of reference.

The first edition of the book was reviewed in NATURE of October 14, 1922. The review led to a correspondence which is interesting in the fact that it concerned the problem which has called for the new matter in the second edition. This new matter is contained, as we have said, in three appendices, which, though each is complete with its own separate topic, are sequential in the argument and cumulative in force. The first deals with the interesting paradox, " Le voyage en boulet." A very striking mathematical demonstration of it is furnished in a letter addressed to M. Bergson, " par un physicien des plus distingués," which he quotes in full. Two observers, Peter and

Paul, are standing together, and each marks the hour O^h on his synchronous clock. Paul is then carried suddenly outwards from the earth a specified distance and back again in a rectilinear and uniform movement relatively to the earth and at a velocity of 259,807 kilometres a second. On his return, he finds that Peter's clock records 8^h, while his, Paul's, records 4^h, and it is proved by means of Lorentz's formulæ that each clock has quite correctly measured the time of one and the same event.

Bergson's reply to his correspondent is clear and precise, and involves no dispute as to actual matter of fact. He is able to admit the discrepancy in the time represented and also to affirm the identity of the time lived, and yet to reconcile the paradox. He begins by pointing out that the shortening of the time as measured by Paul's clock is point to point analogous to the contracting of Paul's dimensions as his distance increases in Peter's perspective. Does Peter think, he asks, that because Paul diminishes in his perspective he is really becoming the dwarf he appears? He does not, and he need not, and neither need he suppose that Paul's retarding clock is really registering shorter time. Paul's time, like Paul's dimensions, is the time *represented* by Peter as that which belongs to a system of reference which is not Paul's, but Paul's-system-in-uniform-translation-relatively-to-his-own. It is only Paul's system for Paul when he is immobilised in the system. The paradox arises from supposing that Peter is immobilised in his system of reference, that Paul similarly is immobilised in his, and that the two systems, *while immobilised*, are moving relatively. There is only one time lived, and that is the time of the system in which the observer is immobilised. This may be Peter or it may be Paul, but if it is Peter, Paul's time is *represented* time for Peter, and *vice versa*. Bergson's conclusion is: the formulæ of Lorentz quite simply express what must be the measurements *attributed* to the system S′, if the physicist in system S is to *imagine* that the velocity of light is the same for the physicist in S′ as it is for him in S.

The second appendix deals with the reciprocity of accelerations. Is there perfect equivalence between relative systems of movement when, as in the shock experienced at the sudden stopping of a train, there is a psychical experience which has itself no equivalent? In other words, can there be pure reciprocity in accelerations when certain of the phenomena concern only one of the systems? The argument of this appendix is especially important, and illuminates for the first time a very puzzling position. Stated briefly, it is as follows. If we analyse the acceleration and fix its elements as a succession of represented systems, each in its turn being a system S′ with represented time t' in relation to an immobilised system S with real time t, then the reciprocity is simple and complete; any system which in relation to a system S is a system S′ can itself be a system S, provided that when S′ changes to S, t' becomes t. The symmetry is perfect. But we, on the contrary, are continually representing to ourselves one immobilised system S, to which we oppose a multiplicity of distinct systems animated by various movements, although we still represent them as one unique system S′. When the passenger is thrown from his seat by the sudden stoppage of the train, it is because the material points of his body do not preserve invariable positions in relation to the train. There is no dissymmetry, but instead of a reciprocity between S with t and S′ with t', we have to make the real time belong successively to S″ with t'', S‴ with t''', and so on. The complexity may be infinite, and what we are trying to do is then to make one immobilised system S reciprocal with infinite systems considered not as infinite but as one and unique.

The most important appendix is the third: it deals with real time and world-lines ("Temps propre et ligne d'univers"). It is not possible to abbreviate the argument, which must be read; here we can only indicate its nature. It takes its start from an equation quoted in full from Jean Becquerel. Given a material system of reference, all the points of which are in the same state of movement (*i.e.* any portion of matter in which the spatial distance separating events is null), the time between two events which an observer will measure is the time τ proper to the system, the time which its clocks are registering. A clock in a moving system (whether moving uniformly or non-uniformly) measures the length, divided by the velocity of light, of the arc of the world-line of the system. This principle is worked out to show that in a system in uniform translation (the earth, for example) two clocks to be identical and synchronous must be in the same place. Let one be suddenly and rapidly displaced, and at the end of a certain time (the time of the system) be replaced, it will be found to be retarded. Bergson accepts Becquerel's demonstration (barely indicated here because the mathematical equations are omitted), and proceeds to show how the physicist and the philosopher have each a distinct interest; the physicist must represent a time which is infinitely variable, the philosopher must affirm a time which is absolute and lived. The two interests must be respected and can be reconciled.

Finally, Bergson considers Einstein's case of a field of gravitation produced by the rotation of a disk. In such a system, he quotes Einstein as saying, "It is impossible to determine time by means of clocks which are immobile as regards the system." But is

it true, asks Bergson, that the disk constitutes *one* system? It is only a system if we suppose it immobile; but in that case we are placing a real physicist on it, and then on whatever point of the disk we immobilise this real physicist with his real clock, we have the time which is one and lived. In short, we have to choose. Either the disk is thought of as rotating, and then gravitation is resolved into inertia. This is how the physicist *represents* it, and not as it is for him living and conscious; but then the times measured by the retarded clocks are represented times, and of these there is infinity; the disk will be a multiplicity of systems. Or else this same rotating disk is thought of as immobile. Then inertia at once becomes gravitation. The real physicist now lives its time, and so considered time is one and the same everywhere.

The importance of the book from the point of view of philosophy can scarcely be exaggerated. It accepts frankly the paradox of relativity, goes behind it, and exposes it. The retarding of clocks in systems accelerated relatively to the observer's immobilised system is shown to be a case in point of the relativity of magnitudes. Just as the real dimensions of an object are its spatial magnitudes for an observer immobilised at that point of the universe at which the object is, so the time τ belonging to any system is the time lived by an observer immobilised in that system. For every immobilised observer the times and spaces of other systems are infinitely variable, but these variations are perspectives, represented not lived.

H. WILDON CARR.

Projective Geometry.

(1) *Principles of Geometry*. By Prof. H. F. Baker. Vol. 2: Plane Geometry, Conics, Circles, Non-Euclidean Geometry. Pp. xv+243. (Cambridge: At the University Press, 1922.) 15*s*. net.

(2) *Higher Geometry: An Introduction to Advanced Methods in Analytic Geometry*. By Prof. F. S. Woods. Pp. x+423. (Boston and London: Ginn and Co., 1922.) 22*s*. 6*d*. net.

(3) *Elements of Projective Geometry*. By G. H. Ling, G. Wentworth, and D. E. Smith. (Wentworth-Smith Mathematical Series.) Pp. vi+186. (Boston and London: Ginn and Co., 1922.) 12*s*. 6*d*. net.

(1) CHRISTIAN VON STAUDT'S "Beiträge zur Geometrie der Lage" was published so long ago as 1857; about the year 1871 Felix Klein wrote a series of papers emphasising the fact that it is possible to build up, on von Staudt's lines, the whole of projective geometry, independently not only of axioms of parallelism but also of the notions of distance and congruence. Yet it is astonishing how little effect this discovery has had upon English treatises on projective geometry, which still, with very few exceptions, base their subject upon metrical geometry, and are content to prove purely projective properties of conics by "projecting into a circle." There are, it is true, Whitehead's two tracts on the "Axioms of Projective Geometry" and "Axioms of Descriptive Geometry," but these, as their titles imply, deal only with the logical preliminaries. There is also G. B. Mathews' "Projective Geometry," which suffers rather from undue compression and somewhat confuses the issue by talking about infinity so early as Chapter II.; and there is the important two-volume treatise by Veblen and Young, which is certainly not for the ordinary man.

There was obviously room for a lucid and logical account of the whole of the more elementary parts of geometry, conics, and quadrics and cubic surfaces, developed from the projective point of view, and that is what Prof. Baker's series on the "Principles of Geometry," of which this is the second volume, aims at supplying. Its publication, then, is an event of the greatest importance. Prof. Baker believes that much time "could be saved by following, from the beginning, after an extensive study of diagrams and models, the order of development adopted in this book; and such a plan would make much less demand upon the memory" than does the traditional treatment. Is it not about time that some such course were adopted for University students of scholarship standard in their first year? The ideas involved are, perhaps, difficult, but not more so than those which the Cambridge freshman is expected to assimilate from lectures on analysis.

In the first chapter a conic is defined in the usual way as the locus of the intersection of corresponding rays of two related pencils of lines in the same plane; next, Pascal's theorem and the theory of polarity are developed; and then there are forty most interesting pages of examples of the application of the foregoing theorems in various directions. The theory of outpolar conics, Poncelet's theorem and Hamilton's extension of Feuerbach's theorem may be mentioned. Chapter II. summarises properties of conics relative to two points of reference, and gives a number of results containing those usually developed as consequences of the notion of distance. The terms current in metrical geometry, *perpendicular*, *circle*, *rectangular hyperbola*, and so on, are used for the sake of clearness, but have here, of course, a much more general meaning, depending upon the choice of the absolute points of reference.

In the first volume of the series an algebraic

symbolism was introduced to accompany the geometrical reasoning; in the third chapter of the present volume this symbolism is applied to the matters in hand. The symbols employed consist of the iterative symbols, and those derived from them as the irrational numbers of arithmetic are derived from the rational numbers, together with combinations of such symbols of the form $x+iy$, i denoting a new symbol such that $i^2=-1$. In Chapter IV. it is shown that if we introduce certain laws of order of succession, the symbols are, in manipulation, indistinguishable from the complex numbers of ordinary analysis. The distinction between real and imaginary elements is then discussed. The last chapter deals with the notion of the interval of two points of a line, and the angular interval of two lines through a point, defined projectively in regard to an absolute conic, and leads up to a discussion of non-Euclidean geometry. There follow two important appendices dealing with certain configurations of points and lines, and, in particular, with the complete figure of Pascal's theorem, which is best considered from four dimensions.

Much of the matter contained in this work is, of course, familiar enough, though often presented from a new point of view; in places, especially in Chapter III., extreme condensation of treatment makes difficult reading, but one can browse with pleasure and profit from almost anywhere in its pages, and surely that is a test of a good book. The printing and diagrams are excellent, as one would expect from the Cambridge University Press; we would like to single out for special mention the frontispiece, the Hexagrammum Mysticum, which any one who has tried to draw the figure will recognise as simply marvellous.

(2) Going on from Prof. Baker's book to Prof. Woods', one feels a little confused. Prof. Woods is concerned with "advanced work in algebraic geometry" and so does not worry about the foundations, but it is rather difficult to determine what his foundations are. One's first impression is that he defines a point (in a plane) by means of three numbers, real or complex, and then the line joining two points x_i, y_i as the set of points $x_i+\lambda y_i$ $(i=1, 2, 3)$, which is quite logical, though in Prof. Baker's opinion it "appears to beg one of the main, and most interesting, questions arising in the foundations of geometry," but then, on p. 28, Prof. Woods refers for the proof of the theorem that any linear equation represents a straight line "to any text-book on analytic geometry." This criticism may appear pedantic, but the underlying idea of the book is, very properly, the group concept, and the logical attitude is, surely, to begin with the projective group and afterwards to consider its sub-groups, the metrical group, and so on. Also discussions of non-Euclidean geometry (Chapter VII.) seem a little unsatisfactory if the idea of distance has been present from the beginning.

Prof. Woods' book, however, contains a very great deal of interesting and valuable matter not elsewhere accessible in any one volume. His plan is to study different co-ordinate systems, based upon various geometric elements and classified according to the number of dimensions involved. Thus in three-dimensional geometry he considers first the circles of a plane and then point and plane co-ordinates; in four-dimensional geometry the lines of three-dimensional space, spheres and four-dimensional point space, in each case studying the meaning of the linear and quadratic equations. Contact transformations, tetracyclical and pentaspherical co-ordinates are also dealt with. There are numerous exercises. The author is to be congratulated on his determination to "preserve the English idiom" by not using such a phrase as "a line *on* a point," although this has considerable authority behind it now and was introduced, we believe, by an Englishman. The word "nonminimum" would have looked better, surely, with a hyphen; the extra expense involved in printing could have been saved by omitting the diæresis in the much more frequently occurring word "coördinate."

(3) There is little to say about the third work under review. It is a clearly set out, elementary school-book on projective geometry on the ordinary lines, built up upon a metric foundation and excluding any consideration of imaginary elements. A desire to be simple has led to some doubtful statements, *e.g.* "the greatest number of points of a figure that lie on a line which is not entirely in the figure is called the *order of the figure*." But the book may be recommended as a good example of its class; and there is an attractive Greek alphabet on p. vi. The historical note at the end is not so good as one would have expected in a book with which Prof. D. E. Smith is associated.

F. P. W.

The Distribution of Mental Products.

A Short History of the International Language Movement. By Albert Léon Guérard. Pp. 268. (London: T. Fisher Unwin, Ltd., 1922.) 21*s.* net.

PROBABLY no subject is more distasteful to the average educated Englishman than the question of an "artificial auxiliary language." If he be a literary scholar, he feels insulted; if a man of business and affairs, he is coldly indifferent and incredulous. A few men of science may, perhaps, be mildly curious and politely tolerant. If anything can awaken interest and overcome prejudice, it will be this book written

by Prof. Guérard, if only by reason of its literary quality and attractive style. But the volume possesses many other merits, since it is by far the best work that has been written on this particular subject. Indeed nothing to compare with it has appeared since the learned and rather ponderous "Histories" of Profs. Couturat and Leau. Moreover, Prof. Guérard takes a wide and dispassionate sweep, considering the respective merits and possibilities of French, English, and Latin, as well as those of the "artificial" languages. Very full information is given with regard to the history and structure of all the more important projects, including, besides the so-called "philosophical" languages, Volapük, Esperanto, Ido, Interlingua, Latino sine Flexione, Idiom Neutral, Panroman, Romanal, etc.

There are three appendices, giving, respectively, a bibliography of the subject, a fairly complete list of all known auxiliary language schemes, and a critical comparison of Esperanto, Ido, Interlingua, and Romanal. There is also an index. Throughout the whole book the author displays a cool and critical judgment, combined with much wit and an incisive literary style. The result makes very interesting reading. He is a firm believer in the possibility (and actuality) of an artificial *auxiliary* language for general human intercourse, and drives his point home by cool reasoning devoid of any vestige of emotional fanaticism. His personal predilections are kept well in the background, though he gives good reasons for preferring a language with an Anglo-Latin etymological basis. Like Dr. Cottrell, however, he is in favour of "getting ahead." Several of the existing systems are, in his opinion, good enough for present work-a-day purposes.

An auxiliary international language is a simple transmitting mechanism for the "distribution and exchange" of ideas and information. It is not a romantic revival or a philological trap for the unwary; but just something of great value and usefulness for hundreds of millions of plain folk, who have not time to acquire real facility in five or six national languages. It is not intended to, and will not and cannot, replace or injure national languages. It comes as no destroyer of the family or national hearth; nor is it the siren music of a denationalised intellectualism, or the fierce breathings of an anti-national proletariat. So the plain decent Englishman need have no fear, though he is often a pretty sincere hater of internationalism. The very word is apt to suggest to him the roaring of some hairy and hydra-headed monster ready to defile the fair green fields of England. Sometimes the prejudice takes another form. The present writer once asked a very distinguished Englishman what he thought about the question of an auxiliary international language. The answer was that he had studied Esperanto, but had given it up because the people who spoke it were not the people he wanted to speak to. The onward march of events will sweep away all such fears and prejudices. Even very distinguished Englishmen use aeroplanes and wireless sets, and are to be found in cinema theatres, and dancing to the strains of a gramophone.

Auxiliary language is not an easy *descensus Averni* or a difficult ascent *per ardua ad astra*. It is not for devil or saint, but for the smooth middle way of life. Nor is it something that exists only in the minds of cranks and idealists, for it is with us here and now, is already much used and advancing rapidly. It is not to be expected that old gentlemen in Club arm-chairs will trouble much about it. The important thing is that teachers might test and develop the idea in the schools. Here in the great workshops of early human development there exists a wonderful field for practical work and for very interesting linguistic and psychological researches. There is, indeed, a veritable gold mine here awaiting those who have the insight and energy to discover and develop it. The phoneticians can render valuable aid with their modern analysis and standardisation of the sounds of human speech, while mathematicians and philosophers need not despise a subject that has deeply interested Descartes, Leibniz, Couturat, and Peano. F. G. D.

Mining and Mineral Deposits.

(1) *Manuel du Prospecteur*. Par P. Bresson. (Bibliothèque professionnelle.) Pp. 452. (Paris: J.-B. Baillière et fils, 1923.) 12 francs net.

(2) *Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire. Copper Ores*. By R. Allen. Pp. x+221. (London: John Murray, 1923.) 7*s*. 6*d*. net.

(3) *Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire. Mercury Ores*. By E. Halse. Pp. ix+101. (London: John Murray, 1923.) 5*s*. net.

(4) *Nickel: the Mining, Refining and Applications of Nickel*. By F. B. Howard White. (Pitman's Common Commodities and Industries.) Pp. x+118. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

(5) *Report on the Cupriferous Deposits of Cyprus*. By Prof. C. Gilbert Cullis and A. Broughton Edge. Pp. 48+5 plates. (London: The Crown Agents for the Colonies, 1922.) 20*s*.

(1) A BRIEF glance at the contents of this manual suffices to arouse grave doubts as to the author's knowledge of real prospectors. No one who

has sat by a prospector's camp fire or shared his hardships in the field, who knows the type of tough, hardy fellow who starts out to prospect an unknown country with the customary simple equipment—often nothing more than pick, shovel and pan, a bag of food, and a gun across his shoulder—could imagine that chemical equations and crystallographic systems could be of the remotest use or of the faintest interest to him in any circumstances whatever. It is quite certain that he would grudge even the small space that this book would occupy in his pack, even supposing that he could understand it.

If the author, on the other hand, had in mind the preparation of a work suitable for the trained mining geologist, such a man as might be selected as the leader of an important exploring expedition, then it can only be said that the scientific section of the book is too rudimentary and inaccurate to be of use to him. To give one example: a thorough knowledge of mineral deposits is above everything else the first essential for a mining geologist; our author informs us that M. De Launay's "Traité des gîtes métallifères" "contains everything that is known" of the science of ore deposits. There is, however, no such book as he names; he must mean either M. De Launay's "Formation des gîtes métallifères," or else the "Traité des gîtes minéraux et métallifères" by Fuchs and De Launay, both of which were published in 1893. Few branches of scientific study have made more progress than has this one in the last quarter of a century, and the statement that a book written thirty years ago presents the sum of our knowledge of the subject to-day is altogether misleading.

As regards the rest of the book, it may be said that only a small portion is devoted to matter that could interest a prospector of any type; nearly one-half of it is taken up with a sketch of mining operations with which the prospector has nothing whatever to do. Thus it would probably be of use to him to have a correct drawing and description showing how to construct a windlass, but this is barely mentioned, whereas many pages are devoted to the headgears and winding machinery suitable to a large working mine. In the same way, ventilating fans, rock drills, dressing plant and other appliances necessary for a mine in full operation are described in what is entitled a prospector's manual. We wonder if M. Bresson thinks that a prospector really uses any of these.

(2), (3) These two volumes constitute additions to the series of monographs on mineral resources issued by the Imperial Institute, and follow closely the general scheme adopted in previous examples. There is an opening chapter describing briefly the more important ores of the particular metal under discussion, their mode of occurrence, and the general principles of the metallurgical processes employed for the production of the metal. The general uses to which it is put, its prices over a period of years, and statistics of production and trade movements complete this part. The second chapter describes the chief occurrences of the ores within the British Empire, and a third chapter is devoted to deposits in foreign countries; finally a set of references to the literature of the particular subject concludes each volume.

Of these two books it need only be said that the work has been painstakingly and carefully performed, and that they constitute useful handbooks for those requiring general information upon the sources of supply of the two metals in question. The compilation of the volume on copper ores was no doubt the easier task of the two, because much has been written on the subject of copper, notably the volume on copper issued in 1922 by the Imperial Mineral Resources Bureau, which had, indeed, rendered Mr. Allen's work practically superfluous, seeing that the earlier book has covered the same ground as the present volume. Perhaps Mr. Allen himself felt this, because it is noteworthy that he omits this particular work from the list of references quoted by him. He has also missed a number of important monographs issued by the United States Geological Survey, which are, moreover, cited in the much more complete bibliography attached to the work of the Imperial Mineral Resources Bureau.

Mr. Halse had far less assistance in his task; the Imperial Mineral Resources Bureau had indeed issued a volume on quicksilver in 1922, and this again is not referred to in the bibliography attached to Mr. Halse's volume. We trust that the omissions in each case are accidental and not intentional. The bulletin of the Imperial Mineral Resources Bureau contains far less technical information upon the mode of occurrence of mercury deposits, and Mr. Halse has done this part of his work extremely well. Of course it so happens that no mercury, practically speaking, is produced within the British Empire, so that the Imperial Mineral Resources Bureau was bound to treat the subject in a somewhat summary fashion, thus making Mr. Halse's work decidedly more necessary for those who desire a general knowledge of the mode of occurrence of mercury ores.

(4) Mr. Howard White's work constitutes a popular handbook giving in a compact form the main facts concerning the occurrence, preparation, refining and applications of nickel. It is probably quite true, as the author states in his preface, that "comparatively little is known about nickel by the general public," but it should in all fairness be added that no one desiring such information can have the least difficulty in obtaining it since the publication in 1917 of the elaborate report of

the Royal Ontario Nickel Commission, with which the name of its chairman, Mr. G. T. Holloway, will always be associated. The little book before us is very well written; within the space of little more than a hundred pages it deals clearly and comprehensively with this subject and should prove extremely useful to the non-technical reader, who wants trustworthy general information concerning a metal, the industrial applications of which have been increasing steadily during recent years. To any one desiring such information the book can be heartily recommended.

(5) This work is necessarily entirely different from those already considered; it is a scientific report, addressed to the Colonial Secretary, upon the known copper deposits in the Island of Cyprus and the possibility of discovering others of economic importance. Apart from the economic aspect of the work, it possesses a high degree of historical and antiquarian interest, for it is generally held that the main supplies of copper in early historic times were derived from this island, which is indeed said to have given its name to the metal. The deposits of copper ore now known are, however, of relatively low grade, consisting in fact of cupriferous pyrites rather than of true copper ores, but this fact is not incompatible with the previous existence, at the outcrops of such deposits, of gozzans rich in oxidised ores, with possibly a zone of secondarily enriched sulphide ores immediately below them. Such ores could have been successfully treated in those ancient times, although it may be doubted whether metallurgical skill was equal to the task of extracting the copper from a low grade cupriferous pyrites. Nor would it be at all extraordinary that an industry carried on for some thousands of years should have worked up every trace of available mineral.

The report indicates that there is only one mine of economic importance known up-to-date in the Island of Cyprus, namely, the Skouriotissa mine, worked by an American company, the Cyprus Mines Corporation. The mineral deposit consists of a large mass of cupriferous pyrites, estimated to contain some six million tons of ore assaying apparently between 49 and 50 per cent. of sulphur and between 1·8 and 2·5 per cent. of copper. An English company, the Cyprus Sulphur and Copper Company, holds a concession on the Lymni mine, estimated to contain 2¼ million tons of ore in the form of disseminated cupriferous pyrites, with 19·5 per cent. of sulphur and 1·25 per cent. of copper, which is thus too poor to be capable of profitable exploitation at the moment. A number of prospecting permits have been granted, and the authors of the report state the grounds upon which they consider it quite possible that other payable ore bodies may yet be discovered. The authors may fairly be congratulated upon the publication of an excellent piece of work, which will interest equally the mining geologist and the archaeologist.

HENRY LOUIS.

Our Bookshelf.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. XXV: Asterias. By Herbert C. Chadwick. Pp. viii+63, 9 plates. (Liverpool: University of Liverpool Press, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 4*s.* 6*d.* net.

To this useful series of descriptions of common marine animals and plants Mr. Chadwick has previously contributed excellent accounts of Echinus, Antedon, and Echinoderm Larvæ. This description of our common starfish (*Asterias rubens*), with its nine carefully drawn and clearly reproduced plates, even betters his previous performance.

While taking advantage of the large amount of previous work on this well-known echinoderm, notably the embryological observations of Profs. MacBride and Gemmill, Mr. Chadwick appears to have verified nearly all his statements by his own dissection and observation, and when he has not done so he is careful to say as much, as well as to indicate one or two points in which he has been led to differ from the majority. Thus, he does not believe that a single ray can regenerate the whole animal; Helen Dean King, he might have noted, proved twenty-five years ago that to effect this the ray must retain approximately one-fifth of the disc.

On the vexed question of the axial organ and axial sinus Mr. Chadwick "is inclined to support Gemmill's conclusions that in Asterids this system is really hæmal, etc." This may be true physiologically and in part, though some of the evidence, as he admits, is not conclusive; but it does not rule out the morphological interpretation of the organ as a genital stolon, a view, by the way, which is far from having originated with MacBride, as Mr. Chadwick implies. Among the divergent accounts of the minute histology of the eye-spot, that of Cuénot is most in accord with Mr. Chadwick's own observations, but differs from them in denying any lenticular thickening of the cuticle. Though in his diagrams he draws and denotes the apical nervous system, "the writer has been unable to find any trace of this system in any of the large number of serial sections examined by him."

One or two points of terminology are open to question. If, as is generally admitted, the terminals are homologous with the [first] radials of Crinoidea, it is puzzling to call the plates which lie proximally to them the first, second, etc., radials; they correspond to the superbasals of Acrocrinus. The rays are numbered according to the method of MacBride and Gemmill. The method which I based on the primary water-pore as a fixed point, and which Sedgwick adopted as conducing to clearness and precision, is, in Mr. Chadwick's opinion, "worthy of the fullest consideration," but he does not seem to have given full consideration to the criticism of the Gemmill-MacBride system published in my "Studies on Edrioasteroidea." In any

case it is surely confusing to apply the term "anterior" to the anal interradius. Such differences of opinion cannot, however, detract from the value of a book which is essentially a clear and accurate statement of things seen. F. A. BATHER.

Les Zoocécidies des plantes d'Afrique, d'Asie, et d'Océanie. Par Prof. C. Houard. Tome 1: Cryptogames, Gymnospermes, Monocotylédones, Dicotylédones (1re partie), Nos. 1 à 1806. Pp. 496. Tome 2: Dicotylédones (2e partie), Index bibliographique, Nos. 1807 à 3293. Pp. 497–1056. (Paris: J. Hermann, 1922–1923.) 2 vols. 100 francs.

DURING the years 1906–1913, Prof. Houard, professor of botany in the University of Strasbourg, placed all cecidologists deeply in his debt by the issue of his three fine volumes on "Les Zoocécidies des plantes d'Europe et du bassin de la Méditerranée." He has now covered Africa, Asia, and Australasia. Only America remains, and it is to be hoped that Prof. Houard will continue his indefatigable labours and encompass the zoocecidology of the globe. The present work is based essentially on the same plan as its predecessor: a short introduction and table of abbreviations, and then a descriptive catalogue of the animal galls of plants, the latter arranged systematically according to Engler and Prantl's "Pflanzenfamilien." This is followed by a bibliographical index of more than seven hundred memoirs of which Prof. Houard himself may be justly proud to claim sixty-five items; by zoological and alphabetical tables of the animal organisms producing galls on plants, an index of plant hosts, and a general index. The volumes are illustrated by a portrait frontispiece and nearly two thousand figures, which although small are quite adequate.

Three thousand two hundred and ninety-three galls are described, and by his ingenious system of abbreviations, and rather rare power of indicating the chief morphological features in a few words, Prof. Houard manages to convey, often in a line or two of print, quite an astonishing amount of information concerning the structure of the gall, its geographical distribution and the causal agent. To each description is appended the bibliography of the particular gall with a note of the memoirs in which a figure is to be found.

Looking through the bibliography one is a little dismayed to find how little British cecidologists have contributed toward a knowledge of the galls found in lands within the British Empire. There are, of course, exceptions, as the well-known names of Lounsbury, Froggatt, Fuller, Green, Maskell, and others indicate, but one must confess that one would like to see British names a little more prominent and numerous. The volumes are very well produced, and botanist and zoologist alike will thank Prof. Houard for placing in their hands so valuable a contribution to so fascinating a subject.

La Radiologie et la guerre. By Mme. P. Curie. (Nouvelle Collection scientifique.) Pp. 144+xvi Plates. (Paris: Félix Alcan, 1921.) 8 francs net.

THE distinguished author of this little book narrates briefly the part which the X-rays played in the medical services of the French Army during the War, or more correctly the radiological experiences which she herself had during those momentous years as technical director of the radiological work of the Patronage National des Blessés.

The book commences with two short chapters on the nature and production of X-rays. Then follows an account of typical installations employed in hospitals and lorries in the field. A chapter is given up to a description of radiological work in hospitals and is devoted mainly to methods of localising foreign bodies and the examination of fractures. Mme. Curie expresses herself in favour of a preliminary fluorescent screen examination before resorting to photography—a subject on which there is a division of opinion in Great Britain. There is a paragraph on the protective measures essential for the X-ray operator. It is now well known that complete protection may be secured; and in Great Britain at any rate, there has latterly been a steady improvement in the working conditions in hospitals and elsewhere, thanks to the work of the X-ray and Radium Protection Committee and the National Physical Laboratory.

Later chapters in the book deal with questions of personnel and organisation of X-ray departments. Brief mention is made of radiotherapy and radium therapy. As was the case with the British army, when the value of the X-rays had been realised there was an enormous expansion of the French radiological services during the War; and Mme. Curie quotes some striking figures in this connexion. For example, she estimates that in the course of the years 1917 and 1918, well over one million X-ray examinations were conducted by the organisation under her direction.

The nation's appreciation of war achievements is now dulled, but this little book prompts the suggestion that an account of the British radiological activities during the War should be put on record.

G. W. C. K.

Light and Colour. By Dr. R. A. Houstoun. Pp. xi+179+10 plates. (London: Longmans, Green and Co., 1923.) 7*s.* 6*d.* net.

DR. HOUSTOUN'S book deals with wide aspects of the science of light and colour, and will be found of interest by photographers and medical students as well as by members of the public generally. There is an excellent chapter on invisible rays, including a description of Prof. Rankine's method of wireless telephony and Dr. Fournier's optophone, by which a blind man is able to read ordinary printed matter, such as books and newspapers. A very clear and simple account of the X-ray spectrometer is included, and also an account of the current views of the structure of the atom. Primary and complementary colours are described by the author, who gives the usual table of complementary colours—that of Helmholtz—while he states that Helmholtz is not so definite on the subject as is generally supposed: he does not give the defects of Helmholtz's methods, by which indeed no consistent results can be obtained. In ascertaining complementary colours it is absolutely necessary that a comparison white light of known composition be used. Without this there is only a mental estimation of the white, in other words guesswork.

Colour blindness and various methods of detecting

the colour blind are described. In this chapter, as in others, the author shows his appreciation of the physiological aspects of the subject. The section on photochemistry deals with the photographic process, the bleaching of the visual purple, the spectral sensibility curve of *Volvox globator*, and the photo-sensory process of the clam, *Mya Arenaria*. The two concluding chapters deal with phototherapy and dangerous light sources, such as the quartz mercury arc, iron and tungsten arcs, which emit ultra-violet radiations of wave-lengths shorter than 2930 Å.U., and cause a painful inflammation of the eyes and skin. The last chapter deals with the psychology of colour. The book is very well illustrated. F. W. EDRIDGE-GREEN.

Die Fernrohre und Entfernungsmesser. Von Dr. A. König (Naturwissenschaftliche Monographien und Lehrbücher, Band 5). Pp. vii+207. (Berlin: J. Springer, 1923.) 7*s.* 6*d.*

THIS book expresses the views of one whose academic knowledge is supplemented by considerable practical experience; it contains, therefore, much information that a designer of optical instruments will appreciate. There are three sections dealing comprehensively with the various types and details of telescopes, micrometers, and rangefinders.

The author has unconsciously rather impaired the agreeable impression of impartiality created by the text through the association of the name of his firm with so many of the instruments illustrated. For example, it might be concluded that the well-known design of dial sight which reflects so much credit upon another German firm was attributable to Messrs. Carl Zeiss.

Many of the illustrations have been reproduced from other works and are already well known, and the author has not completely solved the very difficult problem of representing without confusion the paths of rays through prisms of complex form. He describes the theoretical Ramsden eyepiece which has the field lens in the focal plane, but illustrates the practical Ramsden having the field lens f/4 beyond the focus. Too favourable an impression of the practical clearness of optical glass is created by indicating the absorption for $\lambda = 0{\cdot}48\ \mu$. The date and place of Kepler's death as given do not agree with those inscribed upon his tomb, and stereoscopic rangefinders are advocated for reasons that are no longer accepted by responsible German naval officers.

Notwithstanding these and other minor criticisms that might be expressed, Dr. König's book is an excellent one that should prove most useful to all directly or indirectly interested in the science of optical instruments. JAMES WEIR FRENCH.

Die europäischen Bienen (Apidæ). Bearbeitet von Prof. Dr. H. Friese. Lieferung 2. Pp. 113-208+Tafeln 8-13. 10*s.* Lieferung 3. Pp. 209-304+Tafeln 14-19. 5*s.* Lieferung 4. Pp. 305-400+Tafeln 20-25. 5*s.* (Berlin und Leipzig: W. de Gruyter und Co., 1922–1923.)

THE first part of this work has already been noticed in our columns. Parts II. to IV., which have recently come to hand, are devoted to an account of the behaviour, nesting habits, distribution, parasites, etc., of typical members of the various genera of European bees. The classification adopted is essentially biological, bees being treated as solitary, social, and parasitic as the case may be. Perhaps the best feature in the book is the descriptions of the nesting habits, which are accompanied by numerous figures, and practically all the plates are devoted to various phases of this subject. The majority of the illustrations are original and of a high standard of excellence, and many of the plates are exceedingly attractive. The value of others is somewhat marred by the addition of too much extraneous scenery in the shape of hills, roads, etc., as well as buildings. The author's object no doubt is to portray the surroundings in which the species live. The genera Osmia, Halictus, and Chalcidoma are particularly well treated. Chalcidoma occupies no less than six of the plates, but the great genus Andrena scarcely seems to come in for its adequate share of illustration. We look forward to the appearance of the final instalment of the work, and can cordially recommend the parts already issued as a trustworthy and very readable presentation of the habits and economy of the insects of which it treats.

Elements of Natural Science. By W. Bernard Smith. Part 2. Pp. viii+268. (London: E. Arnold and Co., 1923.) 5*s.* 6*d.*

PUBLIC School science masters have not yet arrived at complete agreement as to how and what science should be taught in general education. The majority of their pupils are not destined for careers and professions in which a definite training in any one branch of science is essential; yet all, in this age which has realised that science is power, should be taught something of the scientific method, and should gain at least an introduction to each of the subjects on which personal and national welfare depend. Mr. Bernard Smith has here made an interesting attempt to steer a safe course between the Scylla of specialist teaching and the Charybdis of smattering, but in places sails perilously near the whirlpool. This Part II. is concerned with electricity and magnetism, astronomy, geology, biology, physiology, and hygiene, and the principles of agriculture. Of these the first three are handled rather more successfully than the others; but throughout the needs of an ordinarily intelligent and well-educated "man in the street" have been kept in mind.

Chemistry, Inorganic and Organic: With Experiments. By C. L. Bloxam. Eleventh edition, revised by A. G. Bloxam and Dr. S. Judd Lewis. Pp. x+832. (London: J. and A. Churchill, 1923.) 36*s.* net.

THE first edition of Bloxam's textbook was published in 1867. It must evidently have undergone very extensive revision. There can be scarcely a page of the original book left. The revision in the present edition has been wisely and thoroughly done, and the book is one which will be found most useful for reference purposes in schools or institutions where large treatises are not available. It covers the whole of chemistry in an interesting manner, and the descriptions of experiments are especially noteworthy. Many of these were new to the reviewer. The book will probably be found most useful to medical and pharmaceutical students for reference purposes, although it has a wider appeal.

Letters to the Editor.

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

Recoil of Electrons from Scattered X-Rays.

IN a recent paper before the Royal Society (as reported in NATURE, July 7, p. 26), C. T. R. Wilson announced that in his cloud expansion pictures of secondary β-rays produced by X-rays shorter than 0·5 Å, tracks of very short range appear. These electrons, he says, "are ejected nearly along the direction of the primary X-rays."

A quantum theory of the scattering of X-rays, devised primarily to account for the change in wave-length which occurs when X-rays are scattered, led me to predict (Bulletin National Research Council, No. 20, pp. 19 and 27, October 1922) that electrons should be ejected from atoms whenever X-rays are scattered. The idea is that a quantum of radiation is scattered in a definite direction by an individual electron. The change in momentum of the radiation, due to its change in direction, results in a recoil of the electron which deflects the ray. The direction of recoil is not far from that of the primary beam, in accord with Wilson's observation on his short tracks.

Corresponding to this momentum acquired by the electron, it has kinetic energy which varies from o when the scattered X-ray proceeds forward, to a maximum value $h\nu \cdot 2\alpha/(1+2\alpha)$, when the ray is scattered backward (P. Debye, *Phys. Zeitschr.* 24, 161, Apr. 15, 1923; A. H. Compton, *Phys. Rev.* 21, 486, May 1923). Here $\alpha = \gamma/\lambda$, where $\gamma = h/mc = 0{\cdot}0242$ Å, and λ is the incident wave-length. The ratio of the maximum energy of a photoelectron excited by an X-ray to the maximum energy of such a recoil electron would thus be $(1+2\alpha)/2\alpha$. But Wilson finds the length of the trails proportional to the square of the energy. The track due to the photoelectron should therefore be $(1+2\alpha)^2/4\alpha^2$ times that of the longest recoil electron tracks.

Taking Wilson's datum that a track of 1 cm. corresponds to 21,000 volts, the equation $Ve = hc/\lambda$ indicates that a ray of wave-length 0·5 Å will eject a photoelectron with a path of 1·4 cm. The recoil electron, taking $\alpha = 0{\cdot}0242/0{\cdot}5$, should accordingly have a range of 0·11 mm., which should just be visible. For his harder X-rays, with a wave-length for example of 0·242 Å ($\alpha = 0{\cdot}1$), the recoil tracks on Wilson's photographs should be as long as 1·7 mm. The quantum idea of X-ray scattering thus leads to recoil electrons moving in the right direction and possessing energy which is of the same order of magnitude as that possessed by the electrons responsible for C. T. R. Wilson's very short tracks.

ARTHUR H. COMPTON.

University of Chicago,
August 4.

As Prof. Compton points out, the phenomena relating to the forward directed β-ray tracks of short range, which appear in air exposed to X-rays of short wave-length, are in agreement with his suggestion that scattering of a quantum may be effected by a single electron.

That the phenomena are in general accordance with Compton's theory was pointed out in my paper (which has now appeared in the current number of the Proc. Roy. Soc.); mention of this was made in my summary of the paper, but was omitted in the abbreviated report of that summary which appeared in NATURE of July 7.

It is obvious that further observations on the range and direction of tracks of this type produced by homogeneous radiations may throw light on some very fundamental questions. The data thus far obtained by this method are not sufficient to decide without ambiguity whether a quantum of radiation scattered by an electron is emitted in one direction only or with a continuous wave-front.

C. T. R. WILSON.

Cambridge, August 24.

Long-range Particles from Radium-active Deposit.

WITH reference to the communication of G. Kirsch and H. Pettersson in the issue of NATURE of September 15, p. 394, on the "Sources of long-range H-particles," the results of an examination by the scintillation method of the particles emitted by radium-active deposit, in which we have been engaged for the past six months, are of interest.

It was found that the active deposit, radium B + C, on a brass disc emitted particles with ranges (in air at 15° C. and a pressure of 760 mm. of mercury) of 9·3, 11·1, and 13·2 cm. respectively, as well as particles of which the range was considerably greater than 18 cm., which were not further investigated, as they appeared to be H-particles. The particles of range 9·3 cm. were previously observed by Sir Ernest Rutherford (*Phil. Mag.*, xxxvii., 1919, p. 571).

Although it would not be possible definitely to decide that these particles were α-rays except by their deflexions in electric and magnetic fields, the appearance of the scintillations strongly suggests that they are α-rays. The numbers of these additional particles were relatively very small; for every 10^7 α-rays of range 6·97 cm. emitted by the source, there were present 380, 126, and 65 particles of ranges 9·3, 11·1, and 13·2 cm. respectively, together with about 160 long-range H-particles.

To ensure that these long-range particles were not produced by collisions by the 6·97 cm. α-particles with air molecules, the experiments on the 11·1 and 13·2 cm. particles were repeated, using carbon dioxide in place of air. In this case the equivalent ranges in air were found to be 11·3 and 13·6 cm. respectively, the agreement being considered satisfactory, as the measurements in carbon dioxide were not made with the same precision as in air.

Moreover, these particles could not have been excited in the mica sheets which were used to provide screens of various stopping powers, for the majority of the experiments were carried out with air or carbon dioxide gaps between the source and the mica, sufficiently large to prevent the 6·97 cm. α-rays from reaching the mica.

The particles under consideration appeared to be independent of the metal on which the deposit was formed, as a check determination of the range of one set of particles, emitted from an active deposit on a platinum disc, gave a value of 11·2 cm.

It seems possible, therefore, that the 12, 13, and 10 cm. H-particles which Kirsch and Pettersson considered to arise from the collisions of α-particles from their emanation tubes with atoms of beryllium, magnesium and lithium, respectively, are actually long range α-particles emitted by the active deposit. It is of interest to note that, should the particles of range 13·2 cm. later prove to be α-particles, they will be the longest range α-particles yet discovered.

Further details of our results and experimental

arrangements will be published when we have completed the examination of the long-range particles from the active deposits of actinium and thorium.

L. F. BATES.
J. STANLEY ROGERS.
Cavendish Laboratory, Cambridge,
September 15.

The Intermediary Hosts of the Human Trematodes, *Schistosoma hæmatobium* and *Schistosoma mansoni* in Nyasaland Protectorate.

I HAVE received a letter enclosing two tubes containing specimens of five species of fresh-water molluscs from Capt. W. H. Dye, Medical Officer, Karonga, Nyasaland, British Central Africa. Capt. Dye writes: "I think I can say that the enclosed specimens represent all the fresh-water molluscs to be found in this district, as I have searched most thoroughly."

Capt. Dye was able to infect two of the species experimentally with *Schist. hæmatobium* and *Schist. mansoni* respectively.

The molluscs have kindly been identified as follows by Mr. G. C. Robson, Zoological Department, Natural History Museum, S. Kensington.

(1) *Lanistes affinis*, Smith (full grown and young).
(2) *Vivipara robertsoni*, Frauenfeld.
(3) *Limnæa natalensis*, Krauss.
(4) *Physopsis sc. globosa*, Morelet.
(5) *Planorbis sp. near sudanicus*, Martens.

Capt. Dye writes of (4) *Physopsis sc. globosa*, Morelet: "They are very common in the marshy pools, although rather difficult to find owing to their predilection for the muddy undersides of reeds, etc., and their habit of dropping off when the plant is touched. They appear to attract *S. hæmatobium* readily, and large numbers of miracidia disappear out of the tube in which they are put, against the control."

Capt. Dye goes on to describe in detail the experiments he made. He finds that the mollusc dies in two days when heavily infected with the miracidia of *Schist. hæmatobium*, after taking precautions to keep the water as free from decomposition matter as possible. The experiments were repeated several times with the same results. The snails were "not killed by *Schist. mansoni*, but one cannot get such concentration of eggs from fæces as from urine."

As to *Planorbis sp. near sudanicus*, Martens, it is referred to as "the one and only species of planorbis in this part of the world (I have most thoroughly searched). This species is not killed by a heavy infection of *Schist. hæmatobium*," but was "infected from a good heavily infected stool with *Schist. mansoni*."

Capt. Dye sent specimens of infected snails, but they died *en route* and were too decomposed for sectioning on arrival. He appears to have discovered that *Physopsis sc. globosa*, Morelet, is the intermediary host of *Schistosoma hæmatobium* in Nyasaland, and possibly he has also found the intermediary host for *Schistosoma mansoni* in Nyasaland (*Planorbis sp. near sudanicus*, Martens).

The other snails which he sent had, he stated, no attraction for either *Schist. hæmatobium* or *mansoni*.

J. B. CHRISTOPHERSON.
London, W.1.

The One-Host Life-Cycle of *Hymenolepis fraterna*, Stiles, of the Mouse.

IN the recently issued third volume of "The Practice of Medicine in the Tropics," edited by Byam and Archibald, Drs. Clayton Lane and Low call in question (on pp. 1821–2) the one-host account of the life-cycle of the well-known tapeworm *Hymenolepis fraterna*, Stiles. This account is principally based upon the work of Grassi and Rovelli and Joyeux, and it is of considerable interest and importance to be certain of the facts, not only because the vast majority of tapeworms in the higher animals most certainly require two hosts in order to complete their life-cycle, but also because these facts have a practical bearing upon the problem concerning the mode of transmission of *Hymenolepis nana* in man.

To ascertain the truth of the matter I have during the last three months selected from a large number of tame mice thirty-four individuals which I have had under close observation for periods varying between 33 and 55 days, during which the fæces had contained no Hymenolepis eggs, and from which it may be concluded that the mice were free from Hymenolepis infection. On July 20 I infected twenty of these mice with large numbers of Hymenolepis eggs obtained from naturally-infected mice, leaving the other fourteen mice as controls. Of the twenty mice infected, eighteen were found to contain cestodes in various stages of development when examined from five to twenty-four days after, one (examined only three days after) probably contained cysticeroids, and one only had apparently remained uninfected. The controls remained uninfected. Since these experiments were conducted under conditions which rendered it impossible for fleas, house-flies, or other animals to serve as intermediate hosts, and since all other necessary precautions were taken, it must be concluded that the one-host account of the life-cycle of *Hymenolepis fraterna* is the correct one. The details of these experiments will be published in full at the earliest opportunity.

W. N. F. WOODLAND.
Wellcome Bureau of Scientific Research,
London.

Polar Climate and Vegetation.

DR. STEFANSSON'S proposition, as put forth in his letter to NATURE of August 4, p. 162, that if either pole of the earth were situated in a lowland area the winter snowfall would be insufficient to produce a permanent ice-cap, is fundamentally based upon the fact that the Arctic lowlands of Canada and Siberia, with a mean annual temperature far below the freezing-point, are yet free from a summer snow-cover and permanent glaciation. This proposition is tantamount to saying that the inner north polar area is permanently glaciated because it happens to be sea, and the south polar area because it happens to be a plateau 10,000 feet high.

That this is essentially a sound conclusion will, I think, appear on a little reflection. Around the North Pole sea-ice forms during the six months night in such quantity that barely half of it can be melted during the six months day, with the consequence that even in July the mean air temperature (as given by Mohn) does not rise above +30° F., or 2° below the freezing-point, while the mean January temperature drops to −40° F.—an extreme "continental" range of temperature at a low general level conditioned by the vast expanse of floe-ice amounting to some two-thirds of the area of the polar sea. On the other hand, the mean July temperature of the Arctic lowlands varies with locality between 40° and 60° F., and, as pointed out by Dr. Stefansson, heat spells of 90° in the shade commonly occur.

The great summer cold of the Antarctic Plateau is at first sight more difficult to understand than the less severe summer cold of the Arctic Ocean. The

south polar area, being a land surface, is entirely dependent on snowfall for its glaciation, and the snowfall there is comparatively small, if only on account of the low vapour content of the air in very cold regions. Yet in spite of the exposure of the high plateau to six months' continuous summer sunshine, except in so far as clouds may sometimes obscure it, the cold continues so intense as to preserve the ice-sheet intact. In the first place, it must be remembered that the Antarctic Plateau, though extensive, is small enough to be chilled in the same way as any other mountain uplift in any latitude rising like an island into the *cold of the free atmosphere*, which is not effectively heated by the sun's rays traversing it. In the second place, the snow-surface reflects so much of the incident solar radiation that comparatively little is available for raising the temperature of the snow to melting-point. These two factors account for the severe summer cold of the Antarctic Plateau; but if the major factor were removed, that is to say, if the plateau, retaining its present horizontal extent and its present amount of snowfall, were lowered to sea-level, it is probable, as Stefansson thinks, that the ice-sheet would disappear in summer, permitting grass, or even spruce forest, to flourish, just as in the Arctic lowlands to-day.

That a reduction to sea-level of the Antarctic Plateau would remove the permanent ice-cap is the opinion, moreover, of Messrs. Priestley and Wright, as expressed in the handsome volume on the glaciology of the second Scott expedition (1910-1913), which has just been published. I do not, however, fully support Dr. Stefansson in expecting that a lowland south polar continent surrounded by an ice-chilled ocean would be liable, at least so often, to the high summer temperature of the Arctic lowlands, and for this reason. In the Arctic lowlands of Canada or Siberia hot spells in June and July may be materially assisted by the passage northward of air heated in the continental regions to the south, and on the contrary cool spells with summer frosts may be occasioned by northerly winds off the ice-chilled polar sea.

Dr. Stefansson has pointed out in his letter of August 4 that the temperature is invariably lowered in hot summer spells in the Mackenzie Valley, as compared with places in Alaska, in consequence of a persistent polar wind which blows up that valley. Now this polar wind up the Mackenzie valley in hot weather is just a local monsoon effect created by the great difference of temperature between the heated land and chilly ocean, and is precisely the predominant type of circulation one would expect to be set up by a lowland south polar continent heated by summer sunshine and encircled by an ice-chilled ocean. Instead of the present glacial anticyclone with outflowing winds, inflowing winds chilled by sea-ice would commonly flow in towards the lowland Antarctic continent and bring a good deal of cloud, rain or sleet, so that the occasions when high-air temperatures of 80° to 90° F. could occur during the southern midsummer, December and January, would be less frequent than in the circumpolar Arctic lowlands in the northern midsummer, June and July, and confined to calm clear conditions.

As regards the dependence of Arctic spruce forest on a short hot summer, Dr. Stefansson makes clearer in his "Northward Course of Empire" than in his letter of August 4, that a factor of enormous importance in high latitudes is the constant summer daylight. As a bioclimatic factor, light is equally important with warmth, and it is apt to be overlooked by climatologists that the contrast between summer and winter is just as much one of light and darkness as of heat and cold in middle latitudes and much more so in polar latitudes. Now it was shown so far back as 1893 that in cold latitudes plants require and utilise more diffuse daylight than in warm latitudes. In the Arctic lands not only is the period of continuous, or nearly continuous, daylight much longer than the period of high temperature which is limited to a few weeks, but on account of the low altitude of the sun the ratio of diffuse to direct sunlight is much greater than in the tropics, so that the intensity of diffuse daylight is relatively great, and there can be no doubt that this factor is all-important in permitting vegetation to push much farther north than would be the case if light were not able to some extent to replace warmth in the economy of plants during the Arctic summer.

The "Northward Course of Empire," reviewed in NATURE of June 23, p. 839, by Dr. H. R. Mill, was written to correct exaggerated views concerning the inhospitality of the "Frozen North," and to show the possibility of settlement in the Arctic lowlands. Many interesting philosophical questions are raised therein. For example, if Dr. Stefansson's generalisation is sound to the effect that the negro, beset on all sides by terrible parasitic enemies, can move to the Arctic and remain healthy if suitably protected from the cold, whereas the more robust Eskimo immediately sickens and dies of germ infections if brought south, because in the comparatively germ-free atmosphere of the far north he has developed no resisting power, the thoughtful reader will inquire whether the high and increasing degree of protection from infection which modern hygiene and medicine is affording to civilised races is not being purchased at the expense of that resisting power which enabled them to survive the ignorance and dangers of the past, so that dire results might follow any temporary withdrawal of the protecting hand through some emergency. At all events, it is clear that a sound medical philosophy will have an eye to the dangers of coddling no less than to those of undue exposure to adverse agencies.

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August 29.

Series Spectra in Oxygen and Sulphur.

A FEW months ago I wrote a paper (Abstract, *Physical Review*, 21, 710, 1923) on "New Series Spectra in Oxygen." It was read at the meeting of the American Physical Society in Washington, D.C., last April. Some questions arose there concerning these series because of their rather unusual character. Hence I re-photographed the spectra of oxygen and obtained data that confirm and extend my earlier results. I also studied the element sulphur, which resembles oxygen in its spectroscopic properties, and obtained, for the first time I think, sulphur spectra in the region of wave-lengths shorter than λ2500.

OXYGEN.—The new series reported at Washington have been extended from two to seven and from one to six members respectively. No second member of the third series was found. In the series terms listed below, the Fowler notation is used with the modification that P is used instead of p for the common head of the new *triplet* series. This change was suggested to me by Prof. R. T. Birge. The wave numbers of the head oP_{123} of the series are 109833, 109674, and 109607. Only the shortest wave-length of each member is noted, but the others were observed and may be readily calculated from the data given here; $oP_3 - 1S$, $2S$, . . . $7S$ are λ's 1302·27, 1039·26,

976·50, 950·95, 937·85, 930·24, and 925·46 respectively; $oP_3 - 2D$, $3D$, . . . $7D$ are 1025·84, 971·76, 948·73, 936·62, 929·59, and 924·92. The wave-lengths of $oP_{23} - 1S$ are 1355·6 and 1358·6, while the $oP_1 - 1S$ line is definitely absent.

SULPHUR.—In extending the spectrum of sulphur into the extreme ultra-violet, I used dry sulphur dioxide at various pressures in both the receiver and connected discharge-tube of the vacuum grating spectrograph. The following is a brief summary of some of the results obtained. Sulphur dioxide gas has a strong absorption band extending from λ2500 to λ1700 where a narrow and relatively transparent region occurs, and then another absorption band extends from λ1650 indefinitely into the ultra-violet. The fine structure of these bands is now being studied in this laboratory. By using low pressures strong spectra have been obtained even in these regions of absorption. Thus I have photographed the spark and arc spectra of sulphur. The spark spectrum consists of many lines and groups of lines and extends to λ350. The most prominent feature of the arc spectrum is a number of triplets of wide separation and constant frequency difference. I have classified these triplets in series by analogy with oxygen. The series' designation and wave-lengths are: $oP_{123} - 1S$, 1826·35, 1820·53, 1807·42; $oP_{123} - 2S$, 1436·92, 1433·27, 1425·11; $oP_{123} - 3S$, 1326·69, 1323·58, 1316·63. $oP_{123} - 2D$, 1485·53, 1481·66, 1472·99; $oP_{123} - 3D$, 1412·92, 1409·41, 1401·55; $oP_{123} - 4D$, 1313·22, 1310·26 . . . (the last line of this triplet was not observed as it is probably hidden by the strong oxygen triplet in this region). $oP_{23} - 1S$ are at 1914·96, 1900·47, and the $oP_1 - 1S$ line is definitely missing as in oxygen. The common head oP_{123} of these series cannot be accurately calculated from the data using the Rydberg law. Fortunately the term $1S$ has been observed by Meissner (*Annalen der Physik*, 50, 713, 1916) in his study of the infra-red, hence the head of these series and all the other terms may be obtained at once from the above corresponding wave-lengths. Thus oP_{123} has the values in frequency units of 82982, 83156, and 83554. Using these values and the observed wave-lengths, $1S = 28227$, $2S = 13384$, etc. Other spectra in sulphur containing these terms would exist in the region of the infra-red and have not yet been observed.

Both the oxygen and sulphur spectra described above show similar characteristics, namely, the intensities of the lines and their separations are inverted as compared with the known spectra of these elements in the visible and infra-red, thus in the new spectra the shortest wave-length of each triplet is most intense, and, as indicated by the data above, the frequency separation is greater between the two more refrangible lines of each triplet. In both elements one triplet has a missing line correspondingly placed. This fact seems to indicate an inner quantum relation which makes its occurrence impossible.

On the new Bohr theory the valence level of oxygen and sulphur is a 2_2, hence a p or P level and my data indicate this to be a triple level. Apparently there exist one stable and two metastable forms of each of the elements atomic oxygen and atomic sulphur. On the assumption that in both elements the oP_{123} level is the valence level, the resonance and ionising potentials of the stable forms as calculated from the data above are: for the oxygen atom, resonance 9·11 volts, ionisation 13·56 volts; for atomic sulphur, resonance 6·50 volts, ionisation 10·31 volts.

J. J. HOPFIELD.

University of California, Berkeley,
August 3.

[IT should be noted that in the foregoing communication the capital letters P, S, D refer to the new triplet series, and in the case of oxygen are not connected with the previously known "singlet" series for which similar designations have been elsewhere adopted. Also, that the terms $1S$ are those associated with the previously known triplet series of oxygen and sulphur.—ED. NATURE.]

Continental Drift and the Stressing of Africa.

MR. WAYLAND in NATURE of August 25, p. 279, brings forward weighty arguments, based on the results of the Geological Survey of Uganda, to rebut the usually accepted view that the Protectorate, like most of eastern Africa, and probably western Africa as well, has been predominantly in a state of tension. I shall be surprised, however, if further work does not disclose the existence of at least some normal faulting with a north and south strike, showing the former existence of east and west tension. It may well be that compression and tension have more than once alternated with each other in Uganda. There is no reason, too, why a change of conditions may not convert a true rift valley formed in a period of tension into one bounded by reversed faults.

I am by no means prepared to admit that the birth of the moon (supposing it to have in fact arisen by separation from the earth) must have necessarily been a "piece of extremely ancient history." Sir George Darwin gives reasons for his belief that it took place considerably more than 50 or 60 million years ago. Now Dr. Holmes's calculations, based on the uranium-lead ratio of certain minerals, show an antiquity of about 500 million years for the beginning of the Cambrian. This would suggest that the interesting event in question may have occurred at some time within the limits of the fossiliferous record.

Nor is there any reason to believe that it must have been marked by stupendous catastrophic disturbances. A sphere of the earth's size yields itself slowly but practically unresistingly to a force acting continuously upon it—in this case the centrifugal force due to its rotation, accelerated more by the progressive condensation of its interior than retarded by the tidal action of the sun.

The process of separation may have been protracted over a considerable time, more perhaps than that represented by a single geological formation. Indeed, there is a great deal to be said for the suggestion that it may have commenced about the middle of the Carboniferous and continued till the close of the Trias. This would account for the fact that in the portion of the earth's crust which has been chiefly studied, that is to say the extra Pacific area, there appears to have been throughout that lengthy period a general, though by no means a complete, recession of the ocean, which would presumably be attracted towards the protruding mass of the moon. At some stages of this emergence the bulk of the atmosphere would be affected in the same way, giving rise in the region antipodal to the moon to a period of marked rarefaction and cold, resulting in the Talchir and Dwyka ice-age which has been recognised not only in South Africa, but also in India, Australia, the Falklands, and South America, all formerly according to Wegener, and I believe he is right, clustered about Africa. If there be any truth in this supposition we should expect the chief period of tension in Africa and its surroundings to have existed in Mesozoic and early Kainozoic times, not in the Palæozoic or pre-Cambrian. The powerful tidal action of the moon, while still comparatively

near the earth, would be responsible for the fact that the readjustment of the earth's crust after a large portion had been removed in the course of the formation of the moon was mainly effected in an east and west direction.

In these circumstances the excessive meridional folding which Prof. Chamberlin postulates as a necessary result of tidal retardation could not be looked for.

The chief value of the formulation of a speculative hypothesis such as I have sketched out is in illustrating and emphasising the interest and importance of detailed study of geological structures, region by region and period by period, throughout the world. It will only be when we have all the facts before us, that we shall be able to solve with any assurance the problems presented by the present configuration of the surface of the globe.

With regard to the use of the words "rift" and "rift-valley," the latter was originally and properly used by Prof. J. W. Gregory for a structural valley due essentially to tension, and I use "rift" in the corresponding sense—of a split in the earth's crust due likewise to tension. This is in close accordance with the popular and literary use of the word "rift." Should at any future time it be clearly proved that the "great rift valley" was never in the whole course of its existence associated with east and west tension, it would then, I submit, have no longer a right to the title.

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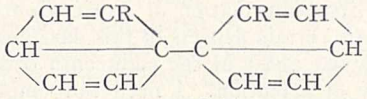
August 31.

Stereoisomerism among Derivatives of Diphenyl.

THE cases of isomerism so far recorded among derivatives of diphenyl, whether connected with optical activity or not (Kenner and co-workers, Trans. Chem. Soc., 1922, 121, 614, etc.), are interesting from the point of view of the possibility of the existence of a stable para-bond in benzene and, more particularly, in diphenyl derivatives. Thus, any 2 : 2′-derivative of diphenyl should be capable of optical activity on the basis of the general formula :



which reveals the presence of four asymmetric carbon atoms.

From the same point of view, the isomeric dinitrobenzidines (cf. for example, Brady and McHugh, Trans. Chem. Soc., 1923, 123, 2047), and some of the substances derived from them, also contain four asymmetric carbon atoms, although this type does not include cases of optically active substances at present.

The above suggestion opens up a large field for investigation. It is interesting to note, in passing, that diphenyl forms a tetra-ozonide, which may indicate that the para-bonded condition is favoured even by the parent hydrocarbon.

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September 4.

The Liesegang Phenomenon—an Historical Note.

THE discovery of the phenomenon of periodic stratification in gels is attributed to Liesegang (*Phot. Archiv*, 1896, 221). Historical accounts of earlier experimental work on the formation of precipitates of sparingly soluble substances in gels are given by Wo. Ostwald ("Grundriss der Kolloidchemie," Dresden, 1909, 208) and by Bradford (*Biochemical Journal*, 29, 29, 1920). The latter author states (*loc. cit.*, p. 29): "The first observation of a series of layers (produced by periodic precipitation in gels) must be ascribed to Lupton (NATURE, 47, 13 (1892))." It may be observed that Ord published experiments before this date on the formation of calcium oxalate in isinglass gels. Details of these experiments are given in his book ("The influence of Colloids upon Crystalline Form and Cohesion," London, 1879), which, in the writer's opinion, has not received the attention it deserves. It appears from the passage quoted below (*op. cit.*, p. 108) that Ord before 1879 (the actual date of the experiment is given in the text as March 12, 1869) had obtained stratified precipitates of calcium oxalate :

"The deposit (of calcium oxalate) was not uniform, but somewhat stratified, forming a layer of greatest density near the calcium solution, a layer of less density, with some opalescence, near the oxalic solution, *and several intermediate layers of still less density, with alternate spaces of extreme scantiness of deposit.*"

In the light of these facts it seems that the priority of the discovery should be taken by Ord.

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August 18.

Urease as a Product of *Bacterium radicicola*.

THE letter by Prof. Werner in NATURE of August 11 "On the Presence of Urease in the Nodules of the Roots of the Leguminous Plants," induces me to state that urease is also produced by the pure cultures of *Bacterium radicicola*, and much more profusely than by the nodules. Such forms as *Viciæ*, *Trifolii*, *Pisi*, are particularly strong in this respect, while *Ornithopodis* and *Lupini* are but feeble urease-producers.

It is interesting to observe that urease is also, in certain cases, a product of the normal papilionaceous plants, first discovered by Takeuchi in the beans of *Soja hispida*, and by me in the seeds and the rind of the branches of *Cytisus Laburnum* and *Glycine chinensis*.

The simplest way for the demonstration of the enzyme is the plate-method which I have described in *Centralblatt f. Bakteriologie*, 2te Abt., Bd. 5, p. 323, 1893, and *Archives Néerlandaises*, 1895. As, however, *B. radicicola* does not grow well on broth-gelatin, or yeast-decoct-gelatin with 1½ per cent. urea, the detection of the enzyme must be made with material taken from colonies previously grown on peas-leaf-gelatin, with 2 per cent. cane-sugar, and then used as little lumps, placed on the yeast-decoct-urea-gelatin plate. After a few minutes the beautiful "iris-phenomenon" becomes visible if urease is present, as a consequence of the production of ammonium-carbonate which precipitates the calcium-carbonate and calcium-phosphate in the particular manner proper to this experiment. The addition of some calcium-malate to the yeast-urea-gelatin enhances the sensibility of the iris-reaction.

The discovery of urease in *B. radicicola* was the result of experiments on the nutrition of this bacterium, performed in 1919 and 1920, with the co-operation of Mr. Ir. L. E. den Dooren de Jong at Delft.

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The Study of Man.[1]

By Prof. G. ELLIOT SMITH, F.R.S.

IN this address I propose to give a sketch of the progress that has recently been made in some of the manifold branches of study concerned with the nature and history of man and his achievements, and to suggest how they can be correlated and integrated as a real science of man with a distinctive discipline.

The recent discoveries of the remains of Rhodesian man and the Nebraska tooth have added a new species and a new genus to the human family, and two continents to the known domain of its extinct members. Intensive studies of the whole series of fossil remains and comparison with the living races of *Homo sapiens* have made it possible for us to construct a family tree of the Hominidæ, and to draw certain inferences as to the nature of the evolutionary changes that have occurred within the human family since it first came into existence. From such investigations it appears that some of the features regarded as distinctive of the highest races of men are temporary phases in the lower races; and, what is much more striking, many of the anatomical traits generally supposed to be peculiar to the human family are found in new-born gorillas and chimpanzees, but are lost by these apes before they attain their maturity. Prof. Bolk, of Amsterdam, has recently been studying this remarkable phenomenon,[2] and has attempted to interpret the facts by the Batesonian paradox that man has attained the human status and the higher races have advanced a stage beyond the lower, not by the acquisition of new characters, but by inhibiting the full development of his ancestral traits. I am unable to accept my distinguished friend's speculations. For man's mental powers and the brain that makes their manifestation possible cannot be explained simply as an unveiling of possibilities dormant in his ancestors, for they are positive additions to his equipment which represent his distinctive characteristic. There is, however, this germ of truth in Prof. Bolk's claim; the apes have in many respects departed further from the primitive ancestral type than man has in that they have become more highly specialised in adaptation to a particular mode of life. They have lost not only many primitive traits that man has retained, but also the plasticity and adaptability that played a decisive part in the attainment of man's mental pre-eminence.

I propose here to submit a tentative pedigree of man's Primate ancestry based upon the results of intensive studies in comparative anatomy and embryology, and discoveries in palæontology, and to use this as the basis for a study of the progressive changes in the brain, which prepared the way for the eventual emergence of those attributes of mind which distinguish man from all other living creatures.

In the course of this inquiry we shall see that during the process of evolution man's Primate ancestors wandered from America to Europe and Asia, and that such world-wide migrations have been continued by certain of their descendants ever since, providing the new environments which weeded out those members of the order that failed to adapt themselves to new circumstances or to specialise and drop out of the race for the attainment of a higher status. Nor did this migration cease with the advent of man himself. He has ever been a wanderer upon the face of the earth; and not until the invention of civilisation did certain groups of human beings become anchored in definite localities. One of the great sources of confusion in modern anthropological discussions is the failure to distinguish between the migration of population and the diffusion of culture: in other words due recognition is not given to the fact that a small group of people of a higher culture can impose the latter upon a large community without necessarily effecting any recognisable change in the physical characters of the people as a whole.

THE DISCOVERY OF TUTANKHAMEN'S TOMB.

When the programme for the British Association meeting was first tentatively drafted, more than six months ago, the attention of the world at large was fixed upon the Theban Valley of the Tombs of the Kings, and the name of the insignificant pharaoh Tutankhamen was on every one's lips. The officers of the Association then decided that the evening lecture should be devoted to an exposition of the scientific results of the exploration of Tutankhamen's tomb, and it was hoped that Lord Carnarvon would have presided at it. I need not dwell upon the tragic events which have made impossible the realisation of either of these proposals. Lord Carnarvon's death has dealt a very serious blow to Egyptian studies just at the moment when it is more than ever important that British prestige in Egypt as a serious patron of archæological study should be maintained and strengthened.

The work in Tutankhamen's tomb has yielded singularly little information of direct scientific value. Yet there are certain aspects of this dazzling illumination of the last phase of the eighteenth dynasty that are worthy of attention. I need not emphasise the value of this discovery in forcing upon the attention of the world the vastness of the achievements of the ancient Egyptians in the fourteenth century B.C. At a time when some of us have been trying to impress this fact upon students of anthropology one cannot refrain from acknowledging the debt to Mr. Howard Carter for having accomplished in one winter what we have been striving in vain to do at the British Association for more than twelve years. There is only one point in connexion with this discovery to which I can refer before I turn to consider other aspects of the study of man.

THE SEARCH FOR GOLD.

The vast quantity of gold actually found in the tomb is a point of special interest, for it raises problems of the utmost significance with reference to the part played by this relatively useless yellow metal in the history of civilisation. At a time when we have lost the use of gold as currency it is interesting to contemplate a stage

[1] Evening lecture delivered to the British Association Meeting at Liverpool, on September 14.

[2] L. Bolk, "The Part played by the Endocrine Glands in the Evolution of Man," *The Lancet*, September 10, 1921, p. 588.

in history before gold coinage was invented, although the metal was being used as tribute. Gold was the first metal used by man, and it was the arbitrary value attached to it for its supposed magical properties as an elixir of life that initiated the world-wide search for it which has now lasted for sixty centuries, although the motive for the search—in other words, the reason for attaching so peculiar a value to the soft yellow metal—has changed. The search for gold has been the most potent influence in the development and the spread of civilisation. From the pictures in the tomb of Tutankhamen's viceroy Huy, we learn that the gold was obtained from Nubia and the Soudan, and we are also shown the peculiar types of ships which brought this tribute down the Nile. The demonstration of the effects of such exploitation upon the Soudan has recently been revealed by the investigations of Prof. Reisner, which have provided us with an object lesson in the process of cultural diffusion such as has been happening in every part of the world since then. In modern times we have seen it in the Transvaal, in Australia, and in California—the settlement of relatively small bands of miners to get gold and incidentally to plant in hitherto waste places of the earth certain of the elements, good and bad, of our civilisation. In the Soudan thirty-five centuries ago the Egyptians were doing what our own people are now doing in the Transvaal. A relatively small band of people of higher culture were making use of the local population to exploit the gold to which the latter had previously attached no value. As the result of the settlement of cultured immigrants in their midst certain of their customs and beliefs were adopted by the indigenous inhabitants and blended with their own customs. In a report upon Prof. Reisner's work in the Soudan which I submitted to the British Association in 1915 (Report, p. 189) the facts relating to this racial and cultural mixture were summarised.

The geographical distribution of archæological remains and the features of the culture reveal to every one who is willing to read the plain story told by these facts, first emphasised by Mr. W. J. Perry, that the same process has been going on ever since the first civilisation was invented, and that it has been the chief motive for the diffusion of culture throughout the world. Whether one examines the distribution of the earliest monuments in Southern India, or the settlements mentioned in the Rig Veda in the North-West, the distribution of ancient settlements in Persia, Siberia, the Caucasus and Asia Minor, or further afield from the ancient East in Europe and the British Isles, in Africa to the Niger and Zimbabwe, in the lands of gold in Malaysia and Eastern Asia, and further still in America, we can read the same story, the same motive and the same result of the exploitation of the local natural resources by the native population under the direction of relatively small bands of alien immigrants.

Many other materials to which a magical or economic value was attached played a part in this process of exploitation. Resin, timber, pearls, copper, flint, jade, turquoise, lapis lazuli, amber, tin, and eventually all metals, were some of the more obtrusive lures that impelled men to embark upon any adventure, however hazardous: and the search for these things was responsible for the world-wide diffusion of culture.

The investigation of the details of these events throws new light upon ancient history and affords a convincing explanation of much that hitherto has been obscure in the history of civilisation.

Ancient Mariners.

Considerations of time will permit me to refer only to one aspect of this world-wide diffusion. The pictures of the boats used by Tutankhamen's viceroy reveal certain peculiar features which were adopted also in sea-going ships in the Mediterranean and Erythræan Seas. These distinctive methods of ship-building have been preserved until the present day in the Victoria Nyanza in East Africa and in certain parts of the Malay Archipelago. They are also revealed in quite unmistakable fashion in sculptures of the Early Bronze Age in Sweden. Here there is a specific illustration not only of the fact of the world-wide diffusion of culture but also of the chief means by which it was effected.

The New Vision in Anthropology.

The investigation of the factors involved in this demonstration of the unity of civilisation brings to light the motives that prompted its origin, and provides us with a new insight into the real meaning of customs and beliefs. It contains the germ of a new method of approach to the problems of psychology, and a means whereby in time the unification of anthropology will be effected and a real science of man created.

During the last twelve years there has been a profound change in most of the fields of investigation concerned with the study of man. Not only has there been a rich harvest of new facts and a fuller understanding of the meaning of such knowledge as we possess, but also there has begun to emerge a radically new attitude toward the problems awaiting solution. Hitherto the investigator who concerns himself with the problems of human structure and function, of the races of man, of the fossil remains of man, of evolution and inheritance, as a rule has refused to discuss customs and beliefs, arts and crafts, social organisation, and the psychological aspects of anthropology which are now commonly called cultural. The two branches of anthropology have been cultivated in water-tight compartments, and the fact that the results achieved in each of them have far-reaching significance for the interpretation of the problems of the other is as a rule totally ignored.

During recent years some of the more far-seeing students of man have been insisting upon what the late Dr. Rivers called the unity of anthropology and the urgency of the need for more co-operation between the different fields of research.[3] Until such integration is effected there can be no real science of man. In this address I propose to give a sketch of the new trends in anthropological thought, and to suggest how they may be unified and focussed upon a definite aim, the interpretation of man's history and human conduct.

Perhaps a simple illustration will explain the value of the correlation of physical and cultural studies. Twelve years ago, when attempting to interpret the

[3] W. H. R. Rivers, "The Unity of Anthropology," *Journ. Royal Anthropological Institute*, 1922; also B. Malinowski on the same subject, NATURE, Sept. 1, 1923, p. 314.

results of the study of ancient Egyptian remains, I plotted out on a map the geographical distribution of an alien people with easily recognisable distinctive features that began to make its way into the Egyptian Delta about 3400 B.C.[4] This people, which played a definite part in Egypt, Babylonia, Crete, and the Mediterranean, and especially in Britain, could be traced without much difficulty to its homeland in Western Asia. Having reached this stage in interpreting the facts, I was greatly perturbed to find that this same unmistakable type was found widespread throughout Polynesia. Having failed to get any help or encouragement from anthropologists, either on the physical or the cultural side, to pursue this subject further, I had no alternative than to resort to ethnological studies to see whether I could not discover cultural evidence to shed some light upon the undoubted facts of race, concerning which I was satisfied that I had unshakable evidence of a widespread migration of people. In Polynesia I found the same general associations between the distribution of these distinctive people and the practices of megalith-building and mummification as I had previously found in the Mediterranean area and Western Asia; and when the evidence came to be studied intensively it seemed to establish upon unshakable foundations the fact of the unity of civilisation and the world-wide diffusion of culture in early times. This conclusion of course has been warmly contested during the last ten years, during which, however, its opponents have repeatedly shifted their ground and taken up new lines of defence. While there is not a scrap of doubt as to the ultimate issue, it is clear that there will be a prolonged conflict such as in the past was necessary to convince people that the earth was not flat, or that man was really evolved from a Simian ancestor.

There are two points in connexion with this theory that I want specially to mention:—(*a*) Its bearing upon the problems of physical anthropology, and (*b*) its relation to psychology. If it can be demonstrated that at certain scattered localities widespread throughout the world the germs of the common civilisation were planted by immigrants, the recognition of the presence of the latter at some places and not at others is a fact of cardinal importance to the student who is attempting to interpret the puzzling results of the intensive study of race in localised areas. When one is dealing with regions like Oceania, where the population is the result of relatively recent immigrations, probably none of them more than twenty centuries old, such considerations are clearly the essence of the whole problem.

I need say no more in justification of the fundamental importance of the close correlation of the work in physical and cultural anthropology. They are parts of one and the same problem, which cannot be solved unless both classes of evidence are given their proper value.

One of the greatest obstacles that has barred the way to such collaboration has been the persistent refusal on the part of ethnologists to distinguish between diffusion of culture and migration of people. The confusion that has arisen from this issue has had far-reaching effects not merely upon the interpretation of the early history of civilisation, but also by implication in creating a bias in favour of the untenable hypothesis that there is a necessary connexion between race and culture.

The proof of the fact of this widespread diffusion of ancient culture is provided (*a*) by the positive evidence that it did occur; (*b*) by the fact that in the history of custom and invention knowledge invariably has spread in the way we postulate, and has ever been the chief incentive to progress in the new foci; and (*c*) by the psychology of invention. If then, it is asked, the fact of diffusion is so certain, why is there so intense an opposition to its admission? Why do the majority of anthropologists cling to a theory that is so obviously false? Their attitude and methods of evasion become more intelligible if one goes back three centuries ago and studies the arguments of the people who refused to admit the error of the flat-earth hypothesis. If it be urged that the opposition in that case was essentially theological, it can be claimed that mediæval theology has not a monopoly of dogmatism against the advancement of science. The errors of ethnological doctrine that still hold the field are largely the outcome of certain incidents in the sixties of the nineteenth century, as the result of which (*a*) the terms used by biologists in the Darwinian controversy were misunderstood and misapplied, and (*b*) in the conflict with such apologists as Archbishop Whately and the Duke of Argyll[5] the ethnologists not only made claims that recent research has shown to be wholly indefensible, but also laid down these false doctrines with all the pontifical air of infallibility which unconsciously they seem to have adopted from their theological opponents. In recent times the attempt has been made to bolster up this false claim by certain specious psychological arguments; and the best hope for ridding anthropological science of so serious a hindrance to progress is to be found in the adoption of serious psychological methods in the investigation of customs and beliefs and the interpretation of the history of civilisation. Nor would the benefit of this closer correlation between ethnology and psychology be one-sided. Psychology has at least as much to gain as ethnology. For the investigation of the meaning of myth and folk-lore, of custom and belief, is coming to play an increasing part in the study of human behaviour. The further development of this tendency is certain to be the chief factor in ridding anthropological studies of the encumbrances of error which still hamper their growth.

Man's Distinctive Attribute.

The study of man can only become transformed into a real science when man's really distinctive attribute, the nature of the human mind, is made the chief subject of anthropological inquiry. The value of psychology as the great integrating factor in anthropology has recently been explained with great lucidity by Dr. Malinowski, and in the rest of my address I want to suggest that the extent of its possibilities for effecting co-ordination is even much wider than the claims he made for it. Psychology can become the bond of union between all branches of anthropological inquiry and the medium whereby a distinctive dis-

[4] "The Ancient Egyptians," 1911 and 1923.

[5] Andrew D. White, "A History of the Warfare of Science," etc., vol. i., p. 305 (1920 ed.).

cipline can be developed to justify the creation of a real science of man.

The full recognition of the mechanism of the diffusion of culture involves a new orientation in psychological investigation, for it points the way to the true explanation of the origin of folk-lore and myth and of custom and belief; and it throws a new light upon the springs of human action and upon the problems of social and political organisation and of education. The outcome of this new movement in ethnology will be to effect a closer bond of union with real psychology and through psychology with the biological sciences that are essential for the full appreciation of the meaning of mental evolution.

It is too often forgotten by students of man's evolution that the fundamental distinctive feature of the human family is the nature and range of the powers of mind, which differentiate it from all other living creatures. The chief aim of the interpreter of this evolution should be to offer some explanation of how these distinctively human attributes were acquired.

With his usual facility of expression Sir James Frazer puts this view with great force. It is all the more welcome because he, who so freely uses the theory of the independent evolution of belief, reproves another ethnologist for too exclusive a devotion to biological methods of interpretation and for forgetting "the part that human thought and will have played in moulding human destiny." He says that some of his colleagues "would write the history of man without taking into account the things that make him a man and discriminate him from the lower animals. To do this, to adopt a common comparison, is to write the play of 'Hamlet' without the Prince of Denmark. It is to attempt the solution of a complex problem while ignoring the principal factor which ought to come into the calculations. It is, as I have already said, not science but a bastard imitation of it. For true science reckons with all the elements of the problem which it sets out to solve. . . . In particular, the science which deals with human society will not, if it is truly scientific, omit to reckon with the qualities which distinguish man from the beasts." [6]

It should, then, be the fundamental aim of any movement to integrate the forces of anthropological inquiry to provide an explanation of how man acquired his distinctive position and how precisely his behaviour was modified by the attainment of such heightened powers of discrimination and ability to profit from his experience.

The Evolution of the Human Brain.

Intensive research in comparative anatomy and embryology and discoveries in palæontology have made it possible for us to reconstruct man's pedigree with a confidence that hitherto would not have been justifiable. Using this scheme as a foundation, we can determine precisely what structural changes, especially in the brain, were effected at each stage of the progress of the Primates toward man's estate; and in the light of the information afforded by physiology and clinical medicine we are able in some measure to interpret the meaning of each of the stages in the attainment of the distinctively human attributes of mind.

[6] "Totemism and Exogamy," 1910, p. 98.

In an address delivered at the Dundee meeting of the British Association eleven years ago, and elsewhere on several occasions since then, I have discussed this problem: but I make no apology for returning to its consideration again. For, as I have said already, it is the fundamental question in the study of man; and recent research has cleared up many difficult points since I last spoke on the subject.

Even before the beginning of the Tertiary period the trend had already been determined for that particular line of brain development, the continuation of which eventually led to the emergence of man's distinctive attributes. Moreover, man, as I said in 1912, is "the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialisations, either of structure or mode of life, which would be fatal to its plasticity and power of further development."

Vision the Foundation of Man's Mental Powers.

The first step was taken when in a very primitive and unspecialised arboreal mammal vision became the dominant sense, by which its movements were guided and its behaviour so largely determined. One of the immediate results of the enhancement of the importance of vision was to awaken the animal's curiosity concerning the things it saw around it. Hence it was prompted to handle them, and its hands were guided by visual control in doing so. This brought about not merely increased skill in movement, but also the cultivation of the tactile and kinæsthetic senses, and the building up of an empirical knowledge of the world around it by a correlation of the information obtained experimentally by vision, touch, and movement. The acquisition of greater skill affected not merely the hands but also the cerebral mechanisms that regulate all movements; and one of the ways in which this was expressed was in the attainment of a wider range and an increased precision of the conjugate movements of the eyes, and especially of a more accurate control of convergence. This did not occur, however, until the flattening of the face (reduction of the snout) allowed the eyes to come to the front of the head and look forward so that the visual fields overlapped. Moreover, a very complicated mechanism had to be developed in the brain before these delicate associated movements of the eyes could be effected. The building-up of the instrument for regulating these eye-movements was the fundamental factor in the evolution of man's ancestors, which opened the way for the wider vision and the power of looking forward that are so pre-eminently distinctive of the human intellect. Our common speech is permeated with the symbolism that proclaims the influence of vision in our intellectual life.

The first stage in this process seems to have been the expansion of the prefrontal cortex and the acquisition of the power of voluntarily extending the range of conjugate movements of the eyes and focussing them upon any object. Then came the laborious process of building up in the mid-brain the instrument for effecting these complex adjustments automatically,[7] so that the animal was then able to fix its gaze upon an object and

[7] John I. Hunter, "The Oculomotor Nucleus in Tarsius and Nycticebus," *Brain*, 1923.

to concentrate its attention upon the thing seen rather than upon the muscular act incidental to the process of seeing it. This represents the germ of attention and of mental concentration in general. But the power of automatically moving the eyes with such accuracy that the images of an object upon the two retinæ could be focussed with precision upon exactly corresponding spots made possible the acquisition of stereoscopic vision, the ability to appreciate the form, size, solidity, and exact position in space of objects. It also prepared the way for the development in each retina of a particularly sensitive spot, the macula lutea, which enabled the animal to appreciate the texture, colour, and other details of objects seen with much more precision than before. Hence probably for the first time in the history of living creatures an animal acquired the power of "seeing" in the sense that we associate with that verb. The attainment of these new powers of exact vision further stimulated the animal's curiosity to examine and handle the objects around it and provided a more efficient control of the hands, so that acts of increasing degrees of skill were learned and much more delicate powers of tactile discrimination were acquired. Out of these experiments also there emerged a fuller appreciation of the nature of the objects seen and handled and of the natural forces that influenced the course of events.

With the acquisition of this new power of learning by experimentation, events in the world around the animal acquired a fuller meaning; and this enriched all its experience, not merely that which appealed to the senses of sight and touch, but hearing also. Thus in the series of Primates there is a sudden expansion of the acoustic cortex as soon as stereoscopic vision is acquired, and the visual, tactile, motor and prefrontal cortex also feel the stimulus and begin rapidly to expand. This increase of the auditory territory is expressed not only in a marked increase of acoustic discrimination but also by an increase in the power of vocal expression. At a much later stage of evolution the fuller cultivation of these powers conferred upon their possessors the ability to devise an acoustic symbolism capable of a much wider range of usefulness than merely conveying from one individual to another cries expressive of different emotions. For when true articulate speech was acquired it became possible to convey ideas and the results of experience from individual to individual, and so to accumulate knowledge and transmit it from one generation to another. This achievement was probably distinctive of the attainment of human rank, for the casts obtained from the most primitive brain-cases, such as those of Pithecanthropus and Eoanthropus, reveal the significant expansion of the acoustic cortex. This new power exerted the most profound influence upon human behaviour, for it made it possible for most men to become subject to tradition and to acquire knowledge from their fellows without the necessity of thinking and devising of their own initiative. It is easier to behave in the manner defined by convention than to originate action appropriate to special circumstances.

Within the limits of the human family itself the progressive series of changes that we have witnessed in man's Primate ancestors still continue; and as we compare such a series of endocranial casts as those of Pithecanthropus, Eoanthropus, *Homo rhodesiensis*, *Homo neanderthalensis*, and *Homo sapiens*, we can detect a progressive expansion of the parietal, prefrontal, and temporal territories, which are associated with the increasing powers of manual dexterity and discriminative power, of mental concentration and of acoustic discrimination.

The study of such factors of cerebral development will eventually enable us to link up the facts of comparative anatomy with psychology, and enable us the better to understand human behaviour. Such wider knowledge will, in time, help us to co-ordinate the principles that underlie customs and beliefs, and from such researches there will eventually emerge a distinctive discipline and a more strictly scientific method.

For the full realisation of this vision, what is necessary above all is that the universities should recognise the importance of this new conception of humane studies and take an active part in building up a science of man that is more scientific than what at present are known as the humanities and more human than biology. The fundamental aim of all education is the fuller understanding of the forces of Nature and of human behaviour. The necessity for attacking the latter problem with more directness and precision is urgent; and it is impossible to exaggerate the importance of a fuller cultivation in our universities of the study of the nature of man and of the springs of human conduct. It lies at the root of all knowledge and the intelligent control of all human affairs. I need not emphasise the tremendous practical importance of such studies to an Empire such as ours at the present time. The Pan-Pacific Conference held in Australia recently is an earnest of the realisation of this fact by statesmen and administrators and of the usefulness of collaborating with men of science to acquire an understanding of subject peoples and their social problems. This policy of peaceful development of the Pacific is a good augury for the fuller recognition of the value of anthropology to the world at large.

Some Bearings of Zoology on Human Welfare.[1]

By Prof. J. H. ASHWORTH, D.Sc., F.R.S.

THE bearings of zoology on human welfare—as illustrated by the relation of insects, protozoa, and helminthes to the spread or causation of disease in man—have become increasingly evident in these later years, and are familiar to every student of zoology or of medicine. At the time of the last meeting of the British Association in Liverpool (1896), insects were suspected of acting as transmitters of certain pathogenic organisms to man, but these cases were few, and in no single instance had the life-cycle of the organism

[1] From the presidential address delivered to Section D (Zoology) of the British Association at Liverpool on September 13.

been worked out and the mode of its transmission from insect to man ascertained. The late Sir Patrick Manson, working in Amoy, had shown (1878) that the larvæ of *Filaria bancrofti* undergo growth and metamorphosis in mosquitoes, but the mode of transference of the metamorphosed larvæ was not determined until 1900. Nearly two years after the last meeting in Liverpool the part played by the mosquito as host and transmitter of the parasite of malaria was made known by Ross. In addition to these two cases, at least eight important examples can now be cited of arthropods proved to act as carriers of pathogenic organisms to man—*e.g.* Stegomyia—yellow fever; Phlebotomus—sandfly fever; tsetse-flies—sleeping sickness; Conorhinus—South American trypanosomiasis (Chagas' disease); Chrysops—*Filaria* (*Loa*) *loa*; the flea *Xenopsylla cheopis*—plague; the body-louse—trench fever, relapsing fever, and typhus; and the tick Ornithodorus—African relapsing fever.

In selecting examples for brief consideration I propose to deal very shortly with malaria, although it is the most important of the insect-carried diseases, because the essential relations between the Anopheles mosquito and the parasite are well known. There still remain lacunæ in our knowledge of the malarial organisms. Ross and Thomson (1910) showed that asexual forms of the parasite tend to persist in small numbers between relapses, and suggested that infection is maintained by these asexual stages. Such explanation elucidates those cases in which relapses occur after short intervals, but the recurrence of the attacks of fever after long intervals can only be explained by assuming that the parasites lie dormant in the body—and we know neither in what part of the body nor in what stage or condition they persist. Nevertheless, the cardinal points about the organism are established, and preventive measures and methods of attack based on a knowledge of the habits and bionomics of Anopheles have been fruitful in beneficial results in many parts of the world.

If we desire an illustration of the vast difference to human well-being between knowing and not knowing how a disease-germ is transmitted to man, we may turn to the case of yellow fever. When this pestilence came from the unknown, and no one knew how to check it, its appearance in a community gave rise to extreme despair, and in many cases was the signal for wholesale migration of those inhabitants who could leave the place. But with the discovery that Stegomyia was the transmitting agent all this was changed. The municipality or district took steps to organise its preventive defences against a now tangible enemy, and the successful issue of these efforts, with the consequent great saving of life and reduction of human suffering in the Southern United States, in Panama, in Havana, and in other places, is common knowledge. It is a striking fact that during 1922 Central America, the West Indies, and all but one country of South America were free from yellow fever, which had ravaged these regions for nearly two centuries. The campaign against Stegomyia is resulting, as a recent Rockefeller report points out, in yellow fever being restricted to rapidly diminishing, isolated areas, and this disease seems to be one which by persistent effort can be brought completely under control.

In 1895 Bruce went to Zululand to investigate the tsetse-fly disease which had made large tracts of Africa uninhabitable for stock, and near the end of the same year he issued his preliminary report in which he showed that the disease was not caused by some poison elaborated by the fly—as had been formerly believed—but was due to a minute flagellate organism, a trypanosome, conveyed from affected to healthy animals by a tsetse-fly (*Glossina morsitans*). In 1901 Forde noticed an active organism in the blood of an Englishman in Gambia suffering from irregularly intermittent fever, and Dutton (1902) recognised it as a trypanosome, which he named *Trypanosoma gambiense*. In 1902 Castellani found trypanosomes in the blood and cerebrospinal fluid of natives with sleeping sickness in Uganda, and suggested that the trypanosome was the causal organism of the disease. The Sleeping Sickness Commission (Bruce and his colleagues) confirmed this view, and showed that a tsetse-fly, *Glossina palpalis*, was the transmitter. Since then much has been learnt regarding the multiplication of the trypanosome in the fly and its transference to man. For some years this was believed to take place by the direct method, but in 1908 Kleine demonstrated "cyclical" transmission, and this was shown later to be the principal means of transference of *T. gambiense*. In 1910 Stephens and Fantham described from an Englishman, who had become infected in Rhodesia, a trypanosome which, from its morphological characters and greater virulence, they regarded as a new species, *T. rhodesiense*, and its "cyclical" transmission by *Glossina morsitans* was proved by Kinghorn and Yorke. Recent reports by Duke and Swynnerton (1923) of investigations in Tanganyika Territory suggest that direct rather than cyclical transmission by a new species of Glossina is there mainly responsible for the spread of a trypanosome of the *T. rhodesiense* type.

The impossibility of distinguishing by their morphology what are considered to be different species of trypanosomes, and the difficulty of attacking the fly, are handicaps to progress in the campaign against sleeping sickness, which presents some of the most subtle problems in present-day entomology and protozoology. Here also we come upon perplexing conditions due apparently to the different virulence of separate strains of the same species of trypanosome and the varying tolerance of individual hosts—on which subjects much further work is required.

The relation of fleas to plague provides one of the best and most recent illustrations of the necessity for careful work on the systematics and on the structure and bionomics of insects concerned in carrying pathogenic organisms. Plague was introduced into Bombay in the autumn of 1896, and during the next two years extended over the greater part of Bombay Presidency and was carried to distant provinces. The Indian Government requested that a commission should be sent out to investigate the conditions. The commission, which visited India in 1898–99, came to the conclusion (1901) that rats spread plague and that infection of man took place through the skin, but—and this is amazing to us at the present day—"that suctorial insects do not come under consideration in connection with the spread of plague." Further observations, however, soon showed this conclusion to be erroneous. Liston found in Bombay in 1903 that

the common rat-flea was *Pulex* (*Xenopsylla*) *cheopis*, that it was present in houses in which rats had died of plague and in which some of the residents had become infected, that the plague-bacillus could multiply in the stomach of this flea, and that the flea would—in the absence of its usual host—attack man. These observations pointed to the importance of this flea in the dissemination of plague, and the Second Plague Commission, which was appointed and began work in 1905, definitely proved that *Xenopsylla cheopis* is the transmitter of the plague-organism from rat to rat and from rat to man.

The mechanism of transmission of the plague-bacillus was worked out by Bacot and Martin in 1913. They showed that in a proportion of the fleas fed on the blood of septicæmic mice the plague-bacilli multiply in the proventriculus—which is provided with chitinous processes that act as a valve to prevent regurgitation of the blood from the stomach—and a mass of bacilli is formed which blocks the proventriculus and may extend forward into the œsophagus. Fleas in this condition are not prevented from sucking blood, because the pharynx is the suctorial organ, but their attempts to obtain blood result only in distending the œsophagus. The blood drawn into the œsophagus is repeatedly forced backwards into contact with the mass of plague-bacilli, and on the sucking action ceasing some of this infected blood is expelled into the wound. The transmission of plague depends on the peculiar structure of the proventriculus of the flea and on the extent to which, in certain examples, the plague-bacilli multiply in the proventriculus. Such "blocked" fleas being unable to take blood into the stomach are in a starved condition, and make repeated attempts to feed, and hence are particularly dangerous.

Until 1913 it was believed that all the fleas of the genus Xenopsylla found on rats in India belonged to one species (*cheopis*), but in that year L. F. Hirst reported that the rat-flea of Colombo was *X. astia*, which had been taken off rats in Rangoon, and described by N. C. Rothschild in 1911. Hirst ascertained that this flea did not readily bite man if the temperature were above 80° F. A collection of 788 fleas from Madras City proved to consist entirely of *X. astia*, and Hirst suggested that the explanation of the immunity of Madras and Colombo from plague was the relative inefficiency of *X. astia* as a transmitter. Cragg's examination (1921, 1923) of 23,657 fleas obtained from rats in all parts of India shows that they include three species: *Xenopsylla cheopis*, *X. astia*, and *X. brasiliensis*. This last species is common in the central and northern uplands of peninsular India, but its bionomics have not yet been investigated. *X. cheopis* is the predominant species in the plague areas, while *X. astia* is the common flea in those areas which have remained free from plague or have suffered only lightly. In Madras City, for example, during the twenty-one years, 1897–1917, plague has occurred in twenty of these years, but the average mortality was only 0·013 per thousand—that is, though the infection has been repeatedly introduced there, it failed each time to set up an epidemic. The significance of an imported case of plague depends in large measure on the local species of Xenopsylla. Hirst has made numerous attempts during the plague season in Colombo to transmit plague by means of *X. astia* from rat to rat, but with negative results, and *X. astia* was never found to behave like a "blocked" *X. cheopis*.

The distinction of *X. cheopis* from *X. astia* is not an entomological refinement with purely systematic significance, but corresponds with a different relation of the species to the epidemiology of plague, and hence becomes a factor of great practical importance. If through these researches it has become possible by examination of the rat-fleas of a locality to estimate accurately its liability to plague, anti-plague measures may henceforward be restricted to those areas in which plague is likely to occur, *i.e.* where *X. cheopis* is the predominant flea. Thus a great economy of effort and of expenditure and a higher degree of efficiency may be achieved; in fact, the problem of the prevention or reduction of plague may be brought from unwieldy to practicable proportions. When it is remembered that since 1896 some ten and a quarter millions of people have died in India from plague, we have a more than sufficient index of the importance of a precise knowledge of the systematics, structure, and bionomics of the insect-carrier of *Bacillus pestis*.

Another of the outstanding features of the period under review has been the extensive and intensive study of the Protozoa. The structure and the bionomics and life-history of these organisms have been investigated with the help of the finest developments of modern technique. It is fitting here to record our acknowledgment to two staining methods—Heidenhain's iron-hæmatoxylin and the Romanowsky stain (including Giemsa's and Leishman's modifications), which have added greatly to our technical resources.

There is time to refer only to certain of the Protozoa which directly affect man. Twenty years ago our knowledge of the few species of Protozoa recorded from the human alimentary canal was defective in two important respects—the systematic characters and the biology of the species—so there was much confusion. Subsequent investigations, and especially those of the last ten years (by Wenyon, Dobell, and others), have cleared up most of the doubtful points, but owing to the difficulties of size and the paucity of characters available, it is by no means easy in practice to distinguish certain of the species. Of the seventeen species now known to occur in the intestine of man, *Entamœba histolytica* has received particular attention. This organism lives as a tissue parasite in the wall of the large intestine, where, as a rule, the damage caused is counterbalanced by the host's regenerative processes. But when the destruction outstrips the regeneration intestinal disturbance results, leading to the condition known as amœbic dysentery. The specific characters and the processes of reproduction and encystment of *E. histolytica* are now well ascertained, and it is realised that in the majority of cases the host is healthy, acting as a "carrier" dangerous to himself, for he may develop into a case of acute dysentery, and to the community—for he is passing in his fæces the encysted stage which is capable of infecting other persons. Whether an infected person will suffer from dysentery or act as a healthy "carrier" apparently depends upon his own susceptibility rather than on any difference in the virulence of different strains of the Entamœba.

In all work with Entamœbæ infecting human beings

there is need for critical determination of the species, for, in addition to *E. histolytica*, a closely similar species, *E. coli*, is a common inhabitant of the intestine. This, however, is a harmless commensal, feeding on bacteria and fragments derived from the host's food. The distinction between the two species rests chiefly upon the characters of the nuclei and of the mature cyst—quadrinucleate in *E. histolytica* and octonucleate in *E. coli*—and considerable care and technical skill are requisite in many cases before a diagnosis can be given. Yet this distinction is definitely necessary in practice, for indiscriminate treatment of persons with Entamœba is indefensible; treatment is only for those with *E. histolytica*; it is useless for those with *coli*, and subjects them needlessly to an unpleasant experience.

A notable result of recent work is the proof that the more common intestinal Protozoa, formerly believed to be restricted to warmer countries, occur indigenously in Britain. This was first established by a group of observers in Liverpool, and has been confirmed and extended by subsequent workers. There is good reason for believing that in Great Britain the incidence of infection with *E. histolytica* is about 7 to 10 per cent., and with *E. coli* about five times as great (Dobell).

The discovery (1903) of Leishmania, the organism of kala azar and of oriental sore, added another to the list of important human pathogenic Protozoa, but the mode of transmission of this flagellate has not yet been proved.

Of the problems presented by the parasitic worms, the most momentous are those associated with Ancylostoma and its near relative Necator, which are prevalent in countries lying between 36° N. and 30° S.—a zone which contains more than half the population of the earth. Heavy infection with Ancylostoma or with Necator produces severe anæmia, and reduces the host's physical and mental efficiency to a serious degree. Until 1898 there was no suggestion that infection was acquired in any other way than by the mouth, but in that year Looss published his first communication on the entry of the larvæ of Ancylostoma through the skin, and in 1903 gave an account of further experiments which proved that dermal infection resulted in the presence of worms in the intestine. At the meeting of the British Association in Cambridge in 1904 Looss demonstrated to a small company his microscopical preparations showing the path of migration of the larvæ. His investigations served to establish the importance of the skin as the chief portal of entry of Ancylostoma, and pointed the way to effective methods of prevention against infection.

Another notable advance in helminthology is the working out of the life-cycle of Schistosoma (Bilharzia)—a genus of trematode worms causing much suffering in Egypt and elsewhere in Africa, as well as in Japan and other parts of the world. These worms when mature live in pairs, a male and female, in the veins of the lower part of the abdomen, especially in the wall of the bladder and of the rectum. The eggs, laid in large numbers by the female worm, provoke inflammatory changes, and cause rupture of the veins of the organs invaded. Until about ten years ago the life-history of Schistosoma had been traced only as far as the hatching of the ciliated larva or miracidium, which takes place shortly after the egg reaches water, but it was then shown that this larva is not, as had been held by Looss, the stage which infects man. Miyairi and Suzuki (1913) found that the miracidium of *Schistosoma japonicum* entered a fresh-water snail which acted as the intermediate host, and Leiper and Atkinson (1915) confirmed and extended this observation, and showed that the miracidia develop into sporocysts in which cercariæ are formed. We owe chiefly to Leiper's work (1915–16) our knowledge of the life-history and method of entry into man of the Egyptian species of Schistosoma. He demonstrated that two species of this parasite occur in Egypt, and established that the miracidia develop in different intermediate hosts: those of *S. mansoni* enter Planorbis, while those of *S. hæmatobium* penetrate into Bullinus—the molluscs being abundant in the irrigation canals. The sporocysts produce cercariæ, which escape from the snails and gather near the surface of the water, and experiments with young mice and rats showed that the cercariæ attach themselves to the skin, enter, and reach the portal system, from which they travel to the veins of the lower part of the abdomen. Infection of man takes place chiefly through the skin when bathing or washing in water containing the cercariæ, though infection may also occur through drinking such water. So, at last, these worms which have troubled Egypt for at least thirty centuries have become known in all their stages, and measures for preventing infection—which were of great use during the War—have been devised, and curative treatment introduced.

Other recent helminthological researches deserve consideration did space permit, for there has been much excellent work on the life-history of the liver-flukes and lung-flukes of man, and the life-cycle of the tape-worm, *Dibothriocephalus latus*, was worked out in 1916–17. Mention should also be made of Stewart's investigations (1916–19) on the life-history of the large round-worm *Ascaris lumbricoides*, during which he made the important discovery that the larvæ on hatching in the intestine penetrate into the wall and are carried in the blood to the liver, and thence through the heart to the lungs, where they escape from the blood-vessels, causing injury to the lungs. The larvæ, now about ten times their original size, migrate by way of the trachea and pharynx to the intestine, where they grow to maturity. During last year Dr. and Mrs. Connal have worked out the life-history of *Filaria* (*Loa*) *loa* in two species of the Tabanid fly, Chrysops, and investigations on other Filarias have thrown light on their structure, but there is still need for further researches on the conditions governing the remarkable periodicity exhibited by the larvæ of some species (*e.g. F. bancrofti*; in some parts of the world the larvæ of this species are, however, non-periodic). The period under review has obviously been one of great activity in research on helminthes, and fertile in measures tending to reduce the risks of infection.

Insects, protozoa, and helminthes not only inflict direct injury on man; they also diminish his material welfare by impairing the health or causing the death of his horses, cattle, and sheep, by destroying food crops during growth, and, in the case of insects, by devouring the harvested grain. The measure of control which man can gain over insects, ticks, and

endoparasitic organisms, will determine largely the extent to which he can use and develop the natural resources of the rich tropical and sub-tropical zone of the earth.

Other applications of zoology to human well-being cannot be dealt with here, but mention should be made of two—the researches on sea-fisheries problems which have formed an important branch of the zoological work of Great Britain for forty years, and the studies on genetics which made possible an explanation of the mode of inheritance of a particular blood-group, and of some of the defects (*e.g.* colour-blindness and hæmophilia) and malformations which appear in the human race.

The Theory of the Affine Field.[1]

By Prof. ALBERT EINSTEIN, For. Mem. R.S.

THE theory of the connexion between gravitation and electromagnetism outlined below is founded on Eddington's idea, published during recent years, of basing "field physics" mathematically on the theory of the affine relation. We shall first briefly consider the entire development of ideas associated with the names Levi-Civita, Weyl, and Eddington.

The general theory of relativity rests formally on the geometry of Riemann, which bases all its conceptions on that of the interval ds between points indefinitely near together, in accordance with the formula [2]

$$ds^2 = g_{\mu\nu} dx_\mu dx_\nu \quad . \quad . \quad . \quad . \quad (1)$$

These magnitudes $g_{\mu\nu}$ determine the behaviour of measuring-rods and clocks with reference to the co-ordinate system, as well as the gravitational field. Thus far we are able to say that, from its foundations, the general theory of relativity explains the gravitational field. In contrast to this, the conceptual foundations of the theory have no relations with the electromagnetic field.

These facts suggest the following question. Is it not possible to generalise the mathematical foundations of the theory in such a way that we can derive from them not only the properties of the gravitational field, but also those of the electromagnetic field?

The possibility of a generalisation of the mathematical foundations resulted from the fact that Levi-Civita pointed out an element in the geometry of Riemann that could be made independent of this geometry, to wit, the "affine relation"; for according to Riemann's geometry every indefinitely small part of the manifold can be represented approximately by a Euclidean one. Thus in this elemental region there exists the idea of parallelism. If we subject a contravariant vector A^σ at the point x_ν to a parallel displacement to the indefinitely adjacent point $x_\nu + \delta x_\nu$, then the resulting vector $A^\sigma + \delta A^\sigma$ is determined by an expression of the form

$$\delta A^\sigma = -\Gamma^\sigma_{\mu\nu} A^\mu \delta x_\nu \quad . \quad . \quad . \quad . \quad (2)$$

The magnitudes Γ are symmetrical in the lower indices, and are expressed in accordance with Riemann geometry by the $g_{\mu\nu}$ and their first derivatives (Christoffel symbols of the second kind). We obtain these expressions by formulating the condition that the length of a contravariant vector formed in accordance with (1) does not change as a result of the parallel displacement.

Levi-Civita has shown that the Riemann tensor of curvature, which is fundamental for the theory of the gravitational field, can be obtained from a geometrical consideration based solely on the law of the affine relation given by (2) above. The manner in which the $\Gamma^\sigma_{\mu\nu}$ are expressible in terms of the $g_{\mu\nu}$ plays no part in this consideration. The behaviour in the case of differential operations of the absolute differential calculus is analogous.

These results naturally lead to a generalisation of Riemann's geometry. Instead of starting off from the metrical relation (1) and deriving from this the coefficients Γ of the affine relation characterised by (2), we proceed from a general affine relation of the type (2) without postulating (1). The search for the mathematical laws which shall correspond to the laws of Nature then resolves itself into the solution of the question: What are the formally most natural conditions that can be imposed upon an affine relation?

The first step in this direction was taken by H. Weyl. His theory is connected with the fact that light rays are simpler structures from the physical view-point than measuring-rods and clocks, and that only the ratios of the $g_{\mu\nu}$ are determined by the law of propagation of light. Accordingly he ascribes objective significance not to the magnitude ds in (1), *i.e.* to the length of a vector, but only to the ratio of the lengths of two vectors (thus also to the angles). Those affine relations are permissible in which the parallel displacement is angularly accurate. In this way a theory was arrived at, in which, along with the determinate (except for a factor) $g_{\mu\nu}$ other four magnitudes ϕ_ν occurred, which Weyl identified with electromagnetic potentials.

Eddington attacked the problem in a more radical manner. He proceeded from an affine relation of the type (2) and sought to characterise this without introducing into the basis of the theory anything derived from (1), *i.e.* from the metric. The metric was to appear as a deduction from the theory. The tensor

$$R_{\mu\nu} = -\frac{\partial \Gamma^\alpha_{\mu\nu}}{\partial x_\alpha} + \Gamma^\alpha_{\mu\beta} \Gamma^\beta_{\nu\alpha} + \frac{\partial \Gamma^\alpha_{\mu\alpha}}{\partial x_\nu} - \Gamma^\alpha_{\mu\nu} \Gamma^\beta_{\alpha\beta} \quad . \quad (3)$$

is symmetrical in the special case of Riemann's geometry. In the general case $R_{\mu\nu}$ is split up into a symmetrical and an "anti-symmetrical" part:

$$R_{\mu\nu} = \gamma_{\mu\nu} + \phi_{\mu\nu} \quad . \quad . \quad . \quad . \quad (4)$$

One is confronted with the possibility of identifying $\gamma_{\mu\nu}$ with the symmetrical tensor of the metrical or gravitational field, and $\phi_{\mu\nu}$ with the antisymmetrical tensor of the electromagnetic field. This was the course taken by Eddington. But his theory remained incomplete, because at first no course possessed of the advantages of simplicity and naturalness presented

[1] Translated by Dr. R. W. Lawson.
[2] In accordance with custom, the signs of summation are omitted.

itself, for the determination of the 40 unknown functions $\Gamma^{\alpha}_{\mu\nu}$. The following brief statement will serve to show how I have endeavoured to fill in this gap.[3]

If the German capital $\mathfrak{H}$ be a scalar density that depends only on the functions $\Gamma^{\alpha}_{\mu\nu}$, then Hamilton's principle

$$\delta\{\int \mathfrak{H} d\tau\} = 0 \quad . \quad . \quad . \quad . \quad . \quad (5)$$

supplies us with 40 differential equations for the functions Γ, when we stipulate that during the variation the functions Γ are to be treated as magnitudes independent of each other. Further we assume that $\mathfrak{H}$ depends only on the magnitudes $\gamma_{\mu\nu}$ and $\phi_{\mu\nu}$, and thus write

$$\delta\mathfrak{H} = \mathfrak{g}^{\mu\nu}\delta\gamma_{\mu\nu} + \mathfrak{f}^{\mu\nu}\delta\phi_{\mu\nu} \quad . \quad . \quad . \quad (6)$$

where we have

$$\left.\begin{aligned} \frac{\partial\mathfrak{H}}{\partial\gamma_{\mu\nu}} &= \mathfrak{g}^{\mu\nu} \\ \frac{\partial\mathfrak{H}}{\partial\phi_{\mu\nu}} &= \mathfrak{f}^{\mu\nu} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (7)$$

At this point it should be noticed that in the theory developed here, the small German letters respectively represent the contravariant density ($\mathfrak{g}^{\mu\nu}$) of the metrical tensor, and the contravariant tensor density ($\mathfrak{f}^{\mu\nu}$) of the electromagnetic field. Thus in a well-known manner is given the transition from tensor densities (expressed by German letters) to contravariant and covariant tensors (expressed by the corresponding italic letters), and a metric is introduced which rests exclusively on the affine relation.

By performing the variation we obtain after some amount of calculation

$$\Gamma^{\alpha}_{\mu\nu} = \tfrac{1}{2}g^{\alpha\beta}\left(\frac{\partial g_{\mu\beta}}{\partial x_{\nu}} + \frac{\partial g_{\nu\beta}}{\partial x_{\mu}} - \frac{\partial g_{\mu\nu}}{\partial x_{\beta}}\right) - \tfrac{1}{2}g_{\mu\nu}i^{\alpha} + \tfrac{1}{6}\delta^{\alpha}_{\mu}i_{\nu} + \tfrac{1}{6}\delta^{\alpha}_{\nu}i_{\mu} \quad (8)$$

where

$$\frac{\partial\mathfrak{f}^{\mu\nu}}{\partial x_{\nu}} = \mathfrak{i}^{\mu} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Equation (8) shows that our extension of the theory, which appears to be so general, leads to a structure of the affine relation that does not deviate more strongly from that of the geometry of Riemann than is required by the actual structure of the physical field.

We now obtain the field equations in the following manner. From (3) and (4) we first derive the relations

$$\gamma_{\mu\nu} = -\frac{\partial\Gamma^{\alpha}_{\mu\nu}}{\partial x_{\alpha}} + \Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha} + \tfrac{1}{2}\left(\frac{\partial\Gamma^{\alpha}_{\mu\alpha}}{\partial x_{\nu}} + \frac{\partial\Gamma^{\alpha}_{\nu\alpha}}{\partial x_{\mu}}\right) - \Gamma^{\alpha}_{\mu\nu}\Gamma^{\beta}_{\alpha\beta} \quad (10)$$

[3] Herr Droste of Leyden hit upon the same idea independently of the present writer.

$$\phi_{\mu\nu} = \tfrac{1}{2}\left(\frac{\partial\Gamma^{\alpha}_{\mu\alpha}}{\partial x_{\nu}} - \frac{\partial\Gamma^{\alpha}_{\nu\alpha}}{\partial x_{\mu}}\right) \quad . \quad . \quad . \quad (11)$$

In these equations the $\Gamma^{\alpha}_{\mu\nu}$ on the right-hand side are to be expressed by means of (8) in terms of the $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$. Moreover, if $\mathfrak{H}$ is known, then on the basis of (7) $\gamma_{\mu\nu}$ and $\phi_{\mu\nu}$, *i.e.* the left-hand sides of (10) and (11), can also be expressed in terms of $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$. This latter calculation can be simplified by means of the following artifice. Equation (6) is equivalent to the statement that

$$\delta\mathfrak{H}^{*} = \gamma_{\mu\nu}\delta\mathfrak{g}^{\mu\nu} + \phi_{\mu\nu}\delta\mathfrak{f}^{\mu\nu} \quad . \quad . \quad . \quad (6a)$$

is also a complete differential, so that if $\mathfrak{H}^{*}$ is an unknown function of the $\mathfrak{g}^{\mu\nu}$ and $\mathfrak{f}^{\mu\nu}$, the following relations will hold:

$$\left.\begin{aligned} \gamma_{\mu\nu} &= \frac{\partial\mathfrak{H}^{*}}{\partial\mathfrak{g}^{\mu\nu}} \\ \phi_{\mu\nu} &= \frac{\partial\mathfrak{H}^{*}}{\partial\mathfrak{f}^{\mu\nu}} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (7a)$$

We now have only to assume $\mathfrak{H}^{*}$. The simplest possibility is obviously

$$\mathfrak{H}^{*} = -\frac{\beta}{2}f_{\mu\nu}\mathfrak{f}^{\mu\nu} \quad . \quad . \quad . \quad . \quad (12)$$

In this connexion it is interesting that this function does not consist of several summation terms which are logically independent of each other, as was the case with the theories hitherto proposed.

In this way we arrive at the field equations

$$R_{\mu\nu} = -\kappa[(\tfrac{1}{4}g_{\mu\nu}f_{\sigma\tau}f^{\sigma\tau} - f_{\mu\sigma}f^{\sigma}_{\nu}) + \gamma f_{\mu}f_{\nu}] \quad . \quad (13)$$

whereby $R_{\mu\nu}$ is the Riemann tensor of curvature. κ and γ are constants, f_{μ} is the electromagnetic potential, which is connected with the field strength by the relation

$$f_{\mu\nu} = \frac{\partial f_{\mu}}{\partial x_{\nu}} - \frac{\partial f_{\nu}}{\partial x_{\mu}} \quad . \quad . \quad . \quad . \quad (14)$$

and with the electrical current density by the relation

$$\mathfrak{i}^{\mu} = -\gamma\mathfrak{g}^{\mu\sigma}f_{\sigma} \quad . \quad . \quad . \quad . \quad (15)$$

In order that these equations may be in accord with experience, the constant γ must be practically indefinitely small, for otherwise no fields would be possible without noticeable electrical densities.

The theory supplies us, in a natural manner, with the hitherto known laws of the gravitational field and of the electromagnetic field, as well as with a connexion as regards their nature of the two kinds of field; but it brings us no enlightenment on the structure of electrons.

Further Determinations of the Constitution of the Elements by the Method of Accelerated Anode Rays.[1]

By Dr. F. W. ASTON, F.R.S.

BY further use of the method of accelerated anode rays, results have been obtained with a number of elements since the publication of the isotopes of copper (NATURE, Aug. 4, p. 162). Details of the method will be published later. Most of the following results were obtained by the use of fluorine compounds of the elements investigated.

The mass-spectrum of strontium shows one line only, at 88. This was obtained in considerable intensity. If any other constituents exist they must be present

[1] A paper read on September 18 before Section A of the British Association Meeting at Liverpool.

in very small quantities, so that it is practically certain that the chemical atomic weight 87·63 at present in use is too low.

Cobalt also appears to be a simple element of mass-number 59, as was to be expected from its atomic weight, which has been determined with great care by a number of observers.

Scandium was successfully attacked by the use of material kindly supplied by Prof. Urbain, of Paris. The only line obtained was at 45. It may be taken provisionally to be a simple element, but the effects are not strong enough to disprove the presence of small quantities of another constituent.

Manganese behaved surprisingly well, and yielded unequivocal results indicating that it is a simple element of mass-number 55. This result is in good agreement with the chemical atomic weight, and is particularly interesting, for 55 is a term in the numerical series 2, 3, 5, 8, 13—all of which had previously corresponded to gaps in the list of weights of known species of atoms.

Gallium fluoride made from a specimen of the hydrate kindly provided by Prof. Richards, of Harvard University, also gave satisfactory results. Gallium consists of two isotopes, 69 and 71. The intensity relation between the lines agrees much better with the atomic weight 69·72 recently published by Richards than that previously in use, 70·1.

Vanadium and chromium give single mass-lines at positions expected from their atomic weights 51 and 52.

Titanium gives a strong line at 48. On one of the spectra obtained there is a faint and doubtful indication of a line at 50. Should this latter be confirmed it would tend to support Honigschmid's value 48·1 for the atomic weight rather than the lower figure 47·85 more recently obtained by Baxter.

Silver in the form of the chloride worked unexpectedly well, and gave two nearly equally intense lines at 107, 109.

Yttrium gives a single strong line at 89, another term of the numerical series already referred to, and completes the analysis of the first 39 elements.

A specimen of potassium hafnifluoride sent from Copenhagen by Dr. Hevesy was experimented with, but in no case were any lines visible in the region of the expected atomic weight of hafnium. This sample contained about 50 per cent. of zirconium, and an extremely faint effect at 90 shown here and on other plates taken with pure zirconium salts suggests this as the principal isotope of this element; but further work is necessary on this point.

Niobium, molybdenum, cadmium, barium, and lead have all been tried without any definite results, and it is feared that difficulties may arise in finding suitable compounds to use in the case of these and other elements not yet analysed. On the other hand, success with scandium and yttrium offers hope of obtaining the mass-spectra of all the rare-earth group.

The following is a list of the elements the composition of which has been first indicated by the use of accelerated anode rays. The mass-numbers were usually determined with reference to the lines of iron or iodine, and no outstanding divergence from the whole-number rule was observed.

Element.	Atomic Number.	Atomic Weight.	Minimum Number of Isotopes.	Mass-numbers in Order of Intensity.
Sc	21	45·1	1	45
Ti	22	48·1	1	48
V	23	51·0	1	51
Cr	24	52·0	1	52
Mn	25	54·93	1	55
Co	27	58·97	1	59
Cu	29	63·57	2	63, 65
Ga	31	69·72	2	69, 71
Ge	32	72·5	3	74, 72, 70
Sr	38	87·63	1	88
Y	39	88·9	1	89
Ag	47	107·88	2	107, 109

Obituary.

Sir Henry Hubert Hayden, F.R.S.

ALL who knew Sir Henry Hayden well enough must recall a passing thought, more than once definitely formulated, that some day his irrepressible keenness for exploring new and little-known lands would lead to accident. Those who had the inestimable privilege of knowing him with real intimacy know well that, if he had to choose a way of ending his career, it would be on a mountain side and in a fight against physical difficulties. He never revealed and probably never entertained but one fear—that the medical history of his family might repeat itself and render him unfit for further exploratory work. It is appropriate that he should be laid to rest near the foot of a great mountain, and appropriate too that it should be the mountain which he had just conquered, for as a mountaineer he was as efficient as he was daring.

To accomplish a difficult task in exploration was in itself his sufficient reward. Kindred spirits and but very few others knew of his accomplishments; for, without being reticent, he never looked to the "gallery": his photographs, maps, sketches, and collections were made readily available to specialists, but rarely, and only under pressure, were they turned into lantern slides. The end of one task was to him the beginning of the next: there never was an interval for popular demonstrations, and little even for rest.

Each geographical enterprise was invariably in a new field, and Hayden's geological work was just as varied—geotectonic problems in the Himalayas, economic mineral questions in various parts of India, pure palæontology, the application of geology to engineering problems, and the microscopic petrology of igneous rocks formed the subjects of his papers, each treated in turn with a thoroughness and sense of relativity that revealed a wide and precise acquaintance with literature, which was always surprising to those who were impressed by his restless physical activity in the field.

Since January 3, 1895, when I met Hayden on his landing at Calcutta to join the Geological Survey of India, I have been in closer and perhaps more constant touch with him than most of his friends, and during those twenty-eight years I never heard from him an ungenerous remark about a colleague, never heard him grumble about the climate, at the work, or even at the inequalities of treatment that seem to be the

inevitable characteristic of every form of official service. Two examples are worth recording, for every friend of Hayden will recognise them as typical.

We were moving camp to a new field where there was a probability that the fast-coming hot weather would soon make work difficult. The hot, west winds, laden with fine dust, had significantly started as a warning that life in tents would soon be impossible. Every day was important, when, through the negligence of a local subordinate official, transport facilities broke down absolutely within twenty miles of our new field. I was annoyed especially because my mail having been directed from headquarters to the new camp, the enforced halt could not be utilised even for office work. There seemed to be no escape from a wasted day of useless grumbling. On rising next morning Hayden was missing, but by noon he turned up loaded with heavy postal packets, and then I found that he had been to fetch my mail, and, as I afterwards discovered, had cycled nearly forty miles over what only an Indian District Board would be content to call a road. Few but Hayden would have thought of it; none but Hayden would have done it silently, as if it were only the usual thing.

Four years later Sir Francis Younghusband was starting on his mission to Lhassa. The remarks in the Director's Annual Report for 1902–3 (Rec. Geol. Surv. Ind., vol. xxxii. pp. 153-156) show why at that time we were anxious to know whether on the northern side of the snow-covered, crystalline range of the Eastern Himalaya there had been an extension of the Mesozoic fossiliferous basin which had been surveyed in Spiti and other parts of the north-western Himalaya. I hurried to Darjeeling to intercept Younghusband, who was then on his way to join the expedition that had already started into Sikkim. He realised the value of the problem and readily offered to give facilities for a geologist to join the party, but warned me that unless an officer could move at once he might be too late. I returned immediately to Calcutta and put the question before Hayden, who promptly volunteered to cancel his local engagements, and although he knew the meaning of winter on the inhospitable plateau of Tibet, did not wait to discuss conditions or settle his local affairs, but moved off within twenty-four hours, trusting to pick up transport and equipment on the way. Within a fortnight there came back a parcel of Spiti shale fossils and a letter that opened a new chapter in Himalayan geology. Hayden was away for more than a year, and how he covered so much ground with such excellent results was known only to him and to his kindred spirit, Sir Francis Younghusband.

Always moving rapidly, but never too hurried to help a colleague; always doing something, but mentally as well as physically, Hayden piled up a record of solid results which would have been the envy in turn of the sportsman, the explorer, the scientific worker and the most orthodox official. After graduating at Trinity College, Dublin, in engineering as well as arts, he made a journey round the world before joining the Geological Survey of India in 1895. He was appointed Director of the Department in 1910 and held office for eleven years. Meanwhile, as a junior officer his work touched most of the provinces of India, but his Himalayan and trans-frontier stratigraphical work naturally attracted most attention, the chief scientific results being included in his memoirs on Spiti and Bashahr (Mem. Geol. Surv. Ind., vol. xxxvi., part 1), on the provinces of Tsang and Ü in Central Tibet (vol. xxxvi., part 2), and on Northern Afghanistan (vol. xxxix., part 1). Just before leaving for Switzerland he completed and sent to the press in French his account of the journey through northern Tibet during 1922, that is, after he had retired from the Indian Government service.

In 1915 the Geological Society awarded Hayden the Bigsby medal, and he was elected a fellow of the Royal Society in the same year, whilst Calcutta University conferred on him the honorary degree of D.Sc. He served successively as president of the Mining and Geological Institute of India and of the Asiatic Society of Bengal. In 1911 his official service was recognised by the C.I.E.; in 1919 he received the senior order of C.S.I., and on the day of his embarkation at Bombay in June 1920, preparatory to retirement from the office of Director of the Geological Survey, his knighthood was gazetted.

The accident which led to Hayden's death with his two guides must have occurred soon after August 12, on his return from an ascent of the Finsteraarhorn, but his body was not found until August 28. The details of his death will never be known, but if the final and determining incident was not a definite attempt to save his companions, it was not Hayden's fault. He was buried by friends on September 1 at Lauterbrunnen, and the selection of the spot would almost certainly be in accordance with his own wish. Perhaps of all the many incidents that one can recall as illustrations of his generous nature, my last glimpse of him was the most characteristic: it was just a few days before he started on his tour in Switzerland; he was busy with his preparations, but looked in to say farewell on his way to see the sick relative of a friend who was away from home. One frequently came across instances of his generosity to the poor and sick, but not even the most intimate of his friends knew them all; as in his work, each act of kindness followed too closely on its predecessor to allow of time for talking about it.

T. H. HOLLAND.

THE issue of the *Physikalische Zeitschrift* for July 15 contains an obituary notice of Prof. O. Lehmann by Drs. A. Schleiermacher and K. Schachenmeier. He was born on January 13, 1855, at Constance, where his father, F. X. Lehmann, was director of the training college. As an only child he spent much time in his father's laboratory and was interested in his search for mathematical law in organic life. He studied under Kundt and Groth at Strasbourg, and after graduating taught in schools in Baden and Alsace until 1883, when he became lecturer and afterwards extra professor at the polytechnic at Aix-la-Chapelle. After a year as extra professor at Dresden he succeeded Hertz as director of the physics department of the technical school at Carlsruhe in 1889. He took a prominent part in the meetings of the scientific society of Carlsruhe and was noted for the experiments with which he illustrated his lectures. He is best known in Great Britain for his work on liquid crystals and for the improvements he made to the microscope to facilitate that work. His death occurred on June 17, 1922, some time after his retirement.

Current Topics and Events.

THE ninety-first annual meeting of the British Association, which closed at Liverpool on Wednesday, September 19, was one of the most successful in the history of the Association, and all who have been concerned in the arrangements for it, whether local or sectional, are to be congratulated upon the gratifying result of their work. More than three thousand members attended the meeting, and the facilities afforded them for social amenities and scientific discussion were much appreciated by all. As nominated by the Council, Sir David Bruce was elected by the General Committee as president for the meeting to be held in Toronto on September 3-10 of next year. The Committee also cordially accepted the invitation from Southampton to meet there in 1925. On Monday, September 17, the honorary degree of doctor of science of the University of Liverpool was conferred upon the following distinguished men of science: Sir Ernest Rutherford; Prof. Niels Bohr, professor of physics in the University of Copenhagen; Dr. E. H. Griffiths; Prof. G. N. Lewis, professor of chemistry, University of California; Prof. G. Elliot Smith, professor of anatomy in University College, London; Dr. Johs. Schmidt, director of the Carlsberg Laboratory, Copenhagen; and Prof. J. C. McLennan, professor of physics in the University of Toronto.

CANON BARNES of Westminster preached the sermon on Sunday last in the Lady Chapel of Liverpool Cathedral on the occasion of the British Association's visit to that city. He dealt with "The Influence of Science on Christianity," and with characteristic courage attributed the waning influence of the churches to the obscurantism and static outlook of many exponents of religion. Christianity has gained much from progress external to itself; the pronounced ethical progress in the Roman Empire in the second century was a wide movement for which religion cannot claim the whole credit; thirteen centuries later the Renaissance had an invigorating effect, producing in the churches changes destined to be as permanent and valuable as they were extensive: the pity was that in the nineteenth century the churches did not take advantage of the changes produced in the outlook of educated men by the scientific movement, but, led by the tractarians, adopted rather an attitude of hostility which has resulted in the modern conflict of ideas among clerics themselves, and has prejudiced educated people against their teachings. "Faith is a necessity of existence. Zealots still contend that there is a moral value in blind faith. But the modern world, so far as it has fallen under the sway of the scientific method, demands that faith shall be reasonable and not blind." Inability to grasp new ideas, reluctance to discard or even to modify theories or beliefs, are qualities perhaps more rare among scientific workers than among theologians; but we are too accustomed to the conservatism of outlook among the former, particularly those whose life-work has been in the direction of elaboration of what are to them fundamental principles amounting to beliefs, to fail to appreciate the magnitude and importance of the task of the best contemporary theologians in combating religious obscurantism.

IF the first accounts exaggerated the number of lives lost, the latest figures reveal the completeness of the disaster caused in Japan by the earthquake of September 1. Although the exact number of deaths caused by earthquake and fire is still unknown, it is estimated that, approximately, 110,000 were killed in Tokyo, 30,000 in Yokohama, 10,000 in Kamakura, 10,000 in the Miura Peninsula, 700 in Odowara and Atami, and 5000 in the Boso Peninsula—a total of 165,700. In Yokohama, about 71,000 houses were destroyed and about 100 escaped damage; in Yokosuka, all but 150 out of 11,800 houses were destroyed; in Tokyo, 93 per cent. of the houses were burnt or crushed. Most of the high concrete buildings damaged in Tokyo show fissures in the third-floor façades, but above and below that floor there is little injury. The fire destroyed a great part of the Imperial University, including 700,000 volumes in the library. At first, the shock at Yokohama was not severe and differed little from those so often felt in Japan. Then, suddenly, there came a swirling motion (the vorticose shock of the Italians), during which practically all houses collapsed instantaneously. Several early reports with regard to the effects of the shock prove to have been erroneous. There was no volcanic eruption in the island of Oshima and none of the islands off the Izu Peninsula disappeared. Dr. Nakamura has made a preliminary investigation of the central area. He finds that the earthquake originated in two separate foci, one between Oshima and Atami, in which the first and more violent movement seems to have originated, the other near the naval station of Yokosuka.

THE Howard silver medal for 1923 of the Royal Meteorological Society has been awarded to Cadet J. C. Needham of H.M.S. *Worcester* for the best essay on "Tropical Storms." The medal was competed for by the cadets from H.M.S. *Worcester*, H.M.S. *Conway*, and the Nautical College, Pangbourne.

THE International Commission of Eugenics met at Lund in Sweden on September 1 and 3 under the chairmanship of Major Leonard Darwin. Various resolutions were passed, and the question where the next international congress should be held was discussed. Profs. Nilsson-Ehle and Johansson were appointed members of the Commission. The Commission was entertained at dinner by the Mendelian Society and visited the Swedish Institute of Genetics at Akarp near Lund, and the Swedish State institute for race biological investigation. These are the only institutions in the world for genetics or eugenics which are State-endowed.

"HEALTH WEEK" is to be celebrated on October 7–13. This movement was instituted in 1912 and the arrangements are made by a committee appointed by the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1. The object of Health Week

is to focus public attention for one week in the year on matters of health, and to arouse that personal responsibility for health, without which all public work, whether by Government or by Local Authorities, must fall far short of its aims. It is suggested that the dominant idea should be "Self Help in Health," and the consideration of what every individual can do for himself and his neighbour in securing a healthy life. While there is this central Health Week Committee, local celebrations in each centre are organised and controlled by local committees, and a circular has been issued for the formation and guidance of the latter, containing suggestions for the programme of events and subjects for lectures. The Health Week Committee is working in cordial co-operation with the National Baby Week Council (already referred to in these columns), and it has been found convenient in several instances to combine the celebrations of Health Week and Baby Week.

AN Empire Mining and Metallurgical Congress is to be held at the British Empire Exhibition in London during the first week in June 1924. The Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Iron and Steel Institute and the Institute of Metals, representing the scientific and technical interests of the mineral and metal industries, with the Mining Association of Great Britain and the National Federation of Iron and Steel Manufacturers, are co-operating as conveners of the Congress. This is the first such Congress to be held, and it is anticipated that succeeding sessions will be held in the Dominions under the auspices of an Empire Council of Mining and Metallurgical Engineering Institutions, which it is hoped will be constituted as a result of the inaugural Congress. Viscount Long of Wraxall will deliver the Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy at the opening session of the Congress, taking mineral resources and their relation to the prosperity and development of the Empire as his subject. The May Lecture of the Institute of Metals to be delivered by Dr. F. W. Aston, on "Atoms and Isotopes," will also form part of the programme of the Congress.

AN unusual insurance claim is recorded by the New York correspondent of the *Times* in a message dated September 13. The University of Indiana took out a policy at a cost of about 30*l.* to insure against possible failure of the party from the University sent to Ensenada, Mexico, to take good photographs of the total solar eclipse of September 10. The expedition was unsuccessful, and the insurance company duly paid out about 300*l.*, which is to go towards the cost of the expedition. A similar insurance policy, but for 2000*l.*, was taken out by the Swarthmore College party, which was also in Mexico. The compensation in this case was to be inversely as the success of the expedition in obtaining photographs. It is stated that good photographs of the solar corona were obtained.

UP to July 2, no less than 826 broadcasting stations had been licensed in the United States. For various reasons, however, chiefly financial, 376 of them have ceased to operate. Nearly half the total number of working stations are run by radio and electrical companies. The rest are run by newspapers, stores, colleges, churches, etc. That the art of broadcasting has come to stay is proved by the fact that only a small percentage of the stations were discontinued because their service was unsatisfactory to the public. In a few cases stations were closed down because of the competition of neighbouring rival stations. In Great Britain there is only a single organisation for broadcasting, and so the public does not get the benefit of improved service owing to competition. On the other hand, however, it is imperative that the industry be in a sound financial position if it is to work satisfactorily.

A MEMORANDUM on the rainfall in India during June and July and the probable amount during August and September has recently been issued by the Indian Meteorological Department. The monsoon was late in arriving on the shores of India, and was weak throughout the month of June. There was a general strengthening of the monsoon currents in the early part of July, and during the month well-distributed rain fell over most of India. For the two months of June and July the rainfall over the plains of India was about 6 per cent. above normal. The excess was large in Lower Burma and in the North-West Frontier Province and Rajputana West. The amount was short of the normal by more than 20 per cent. in most of the Madras Presidency, Orissa, the East Central Provinces, Berar, the West United Provinces, and mostly along the western frontier. The forecast issued in the early part of August states that there is no reason to expect any large departure from the normal in the rainfall of India generally in August and September. Reports received from India by the India Office show for the mid-week in September that there was an excess of rain in west Central India, north Hyderabad, and south-east Madras; normal amounts in Lower Burma, Orissa, west Central Provinces, and north Madras; elsewhere rains were scanty.

PROF. A. R. FORSYTH recently delivered a lecture on the life and work of Sir Isaac Newton, under the auspices of the London County Council, and it is published as an article in the *Empire Review* for September. This is an opportune moment to refresh the public memory on Newton's life and achievement, when so much interest is being taken in Einstein's modification of the Newtonian law of gravitation. In addition to a biographical sketch, the article gives a summary of the state of mathematics and astronomy when Newton was at Cambridge, and the preparatory work done by Copernicus, Tycho Brahé, Kepler, and Galileo in leading up to the Principia. It is explained that the geometrical methods of the Principia were adopted, because the validity of the infinitesimal method, which Newton had himself employed, was still a matter of controversy. Comment is made on the curious fact that Newton took a degree of the earth's circumference as 60 miles in his first abortive

test of his law; the correct value had been published in England thirty years earlier by Richard Norwood. The fact that international jealousy delayed the universal acceptance of the law of gravitation seems strange to us now; there is, however, a slight echo of it in the antipathy shown to Einstein in some quarters, because of his nationality. The article shows the important part that Voltaire played in persuading the French of the truth of Newton's law. Thus we find that before the return of Halley's comet in 1759, Clairaut and Lalande calculated its perturbations by gravitational methods. Prof. Forsyth makes the practical suggestion that the bicentenary of Newton's death in 1927 should be marked by a new edition of his collected works. There has been none since Horsley's edition in 1785, and many additional manuscripts have been discovered since that date.

THE Almanac for the year 1923 published by the Egyptian Government contains, in addition to the usual statistical information, a good deal of matter of scientific interest. There are chapters on the geographical features, and special attention is given to the Nile. Agriculture and antiquities receive considerable attention, and there is a long section on irrigation. It is noted that the almanac is intended to be explanatory and descriptive rather than statistical, and in this respect is intended to supplement the "Annuaire Statistique." The book is a valuable volume of reference on Egypt.

Our Astronomical Column.

A LARGE FIREBALL.—Mr. W. F. Denning writes: "On September 7, at 7.45 P.M., G.M.T., a large fireball was observed from many places in the south-west of England. As viewed from Par, Cornwall, it appeared as large as the full moon, and passed from the west over north-west, and finally disappeared in north-north-west. It left a brilliant trail of light, and this remained conspicuously obvious to the unaided eye during five minutes. The trail exhibited some singular changes of shape and position while it continued in sight. It first assumed a vertical direction, after which the extremities curved to the left and formed a semi-circle.

"A number of other observers in Cornwall have reported observations of the phenomenon, and among other places it appears to have been well observed at Fowey, Liskeard, and Polruan. The object was also seen from Southampton, from which place the enduring streak was situated due west at an altitude of 16°."

STELLAR MASSES.—Accumulating statistics on binary systems, combined with the great increase in the number of fairly trustworthy parallaxes, have made it possible to deduce mean values of the stellar masses for each spectral type. Messrs. Russell, Adams, and Joy investigate the matter in a joint paper in Pub. Ast. Soc. Pacific for August, using about 400 stars. They assign to type O masses of 6 to 9, to type B mass 6, to giants of types A to G masses 2 to 4, and to the dwarfs of all classes masses $\frac{1}{2}$ to $2\frac{1}{2}$; in each case the unit is the sun's mass.

On plotting mass against absolute magnitude, they obtain a graph that is practically a straight line, though with a slight upward bend for type B. This result seems to lead to a fairly obvious corollary, which is not, however, given by the authors. It is that the duration of the stellar universe in the past is of the same order as that of the luminous period of individual stars. If it were much greater than this, then even the most massive stars would have had time to distribute themselves among all the ranks of absolute magnitude. The same conclusion is obtained by dynamical studies of the stellar motions, which do not indicate any great preponderance of non-luminous stars.

The recently published report of the Cape Observatory states that the stellar masses are also being investigated there. The results suggest that the masses group themselves about certain standard values, $11\frac{1}{2}$, $5\frac{3}{4}$, $2\frac{3}{4}$, $1\frac{1}{4}$ of the sun, each being about double the following. If this law should be established, it would indicate that the large masses were determined by some physical cause, and that they were liable to successive subdivision into equal parts.

HEAT RADIATIONS OF PLANETS.—Allusion has already been made in these notes to the investigation by Messrs. Edison Pettit and Seth Nicholson on the dark heat-waves emitted by the planets. These are isolated by the use of a cover-glass transmitting between 0·3 μ and 5·5 μ (with a weak extension to 7·5 μ), and a water-cell transmitting between 0·3 μ and 1·3 μ. The curve of atmospheric transmission at Mt. Wilson is a very complicated one, with eight minima between 0 and 8 μ, and two maxima between 8 μ and 14 μ. The dark planetary radiations are chiefly in the latter region. The deflexion from the planet Mercury has been compared with that from the moon, the ratio of radiation per unit area being 264/206, a smaller ratio than would be expected in view of Mercury's proximity to the sun. The authors make the suggestion that it may indicate a rapid rotation of Mercury; they note in corroboration of this that they obtain a sensible deflexion even from the dark portion of Mercury's disc.

Their former measures indicated practically no dark heat from Jupiter, but the present series gives 78·1 per cent. of its radiation between 0·3 μ and 1·3 μ, 15·3 per cent. between 1·3 μ and 5·5 μ, and 6·6 per cent. between 8 μ and 14 μ.

A SMALL STELLAR MASS.—*Astr. Nachr.*, No. 5246, contains an investigation of the orbit of the binary O. Struve 400, by P. Meier. The position for 1900 is R.A. $20^h\ 6^m\ 54^s$, N. Decl. 43° 39′, magnitude 7·7, spectral type G 3; trigonometrical parallax 0·043″ (Sproul Observatory), spectroscopic parallax 0·030″ (Mt. Wilson). The elements obtained are: period 84·4 years, periastron 1885·1, e 0·48, ω 19·4°, Ω 143·9°, i 62·5°, a 0·428″. The observations used extend from 1843 to 1922, so that practically a revolution has been completed. Using the Sproul parallax, the sum of the masses is 0·138 of the sun. (By a slip this is printed in *Astr. Nachr.* as 0·014 of the sun.)

The smallest stellar mass hitherto measured is that of the faint component of Krüger 60, which is about one-seventh of the sun; but if the present result is trustworthy, the joint mass of the pair is equal to that of this star.

A comparison of observed and computed positions is given. The agreement is fair, considering the closeness of the pair. The star is one that should be kept under observation. The components are furthest apart, 0·62″, in 1932; the separation is more than 0·50″ till 1948.

Research Items.

THE HORSE IN BABYLONIA.—In the June issue of the Philadelphia *Museum Journal* Mr. Leon Legrain describes a series of Babylonian seals in the museum collection. In one of the most remarkable the rider, whip in hand, is represented with a bird-like head in profile with no distinct hair or beard, mounted on an animal which may be a horse or a donkey. Mr. Legrain is half disposed to regard this as the first representation of the horse in Babylonia, but this is far from certain. In the only known example of this type the animal has been called a bull, and the rider identified with the thunder god, Ramman Adad. But as the seal probably dates from the time of the Guti invasion, this mode of riding astride may be a new and foreign feature imported from the north-east by the Guti people.

EFFECT OF DRYING UPON THE SKULL.—In an interesting paper in the *Journal of Anatomy* (vol. lvii., pt. iv., July 1923), T. Wingate Todd discusses the effect of maceration and drying upon the linear dimensions of the green human skull. His observations cover the effects of drying upon twenty-four macerated skulls and the differences between eight green skulls and the same within twelve hours of emergence from the macerator. He concludes that great individual variation occurs in percentage shrinkage, which, relatively small for length, increases somewhat for breadth and height, upon transformation from the green to the dry macerated state. The average shrinkage (all dimensions) amounts to about 1·1 per cent. of the final measurement. The duration of measurable shrinkage is about three weeks; but shrinkage demonstrable by shifting of the Euryon may continue for three months. Sex, stock, age, cranial thickness, cranial shape, and the condition of sutures are all eliminated as factors having no influence upon shrinkage. In passing through the stage of maceration, and during the first few hours of drying, the green skull loses a total average of 0·84 mm. in length, breadth, and auricular height. The average total shrinkage in complete transformation from the green to the dry macerated state is given as 5·6 mm., corresponding to a reduction of about 42 c.c. in a cranium of some 1500 c.c. capacity. The writer further gives examples showing that, given the linear dimensions in green and dry macerated states, it is possible to calculate the shrinkage in capacity to within a few cubic centimetres by either the Cleveland formula or those of Lee and Pearson.

BIRD CENSUSES IN THE UNITED STATES.—The United States Department of Agriculture has just published, as Bulletin No. 1165, a "Report on Bird Censuses in the United States: 1916 to 1920," by May Thatcher Cooke, of the Bureau of Biological Survey. The paper deals with an interesting attempt to establish a statistical basis for the study of the problems of bird population—the numbers and distribution of birds of different species, annual and other fluctuations, and the effects of irrigation, of cultivation, of the clearing of woodlands, and of protective legislation. The subject is one both of scientific interest and of economic importance: the study of it is not unknown in Great Britain, but it has not so far been undertaken on an important scale. A census takes the form of an annual count of the number of breeding pairs on a defined tract of land which is taken to be representative of the district as a whole. The conclusions so far reached in America, as mentioned in the paper under notice, are purely tentative, and only a part of the United States is adequately covered by the records for the period. For the section of the country lying north of Maryland and the Ohio River and east of the Great Plains, a little more than one pair of birds to the acre is found to be the present average for farm land. For the land immediately surrounding the farm buildings, and including lawns and orchard, the average is about 130 pairs per 100 acres, the estimated population of an entire farm of 100 acres being about 112 pairs. The American robin (*Turdus migratorius*) is the most abundant species in those States lying north of North Carolina and east of the Mississippi, and the alien house-sparrow (*Passer domesticus*) takes second place: for farm land in this section there are about 9 pairs of robins and 8 pairs of sparrows per 100 acres. Further and more comprehensive figures should make interesting comparisons possible.

THE OPALINID CILIATE INFUSORIANS.—Dr. M. M. Metcalf has recently published (U.S. Nat. Mus., Bull. 120) what he describes as a preliminary review—a memoir of 484 pp., with 258 illustrations—of these ciliates which live in the rudimentary cæcal portion of the rectum of Anurid amphibia. Most of the material used in the study of the 150 new species, sub-species, and formæ was obtained from museum specimens of Anura which had lain long—some for more than eighty years—in alcohol. The author gives a general account of the structure and life-history of *Protoopalina intestinalis*—a binucleate opalinid—and deals in some detail with mitosis and other nuclear phenomena in this and other forms. He concludes that each ordinary nucleus of an opalinid contains both trophic and reproductive chromatin in full activity. Dr. Metcalf discusses the relationships (*a*) of the four genera—Protoopalina, Zelleriella, Cepedea, and Opalina, and (*b*) of the family. He suggests that the Opalinidæ and Trichonympha may have arisen from similar ancestors, and that still more probably the Euciliata arose from ancestors which had become disturbed in their relations of mitosis and fission, and that they had passed through a pseudobinucleate condition to one of true binucleation, finally reaching their present structure, having two nuclei—one hypertrophied for metabolism, the other inactive except during the sexual period. An important section of the memoir deals with the geographical distribution of the species of Opalinidæ and the families and sub-families of the Anura.

SKIN SPOT OF POTATOES.—Skin spot has frequently been regarded as a relatively unimportant blemish upon the potato tuber, so that considerable interest was aroused by the recent announcement by Shapovalov (*Journ. of Agricultural Research*, vol. 23, pp. 285-294) that the pustules of this disease represent a primary stage of corky scab, a much more serious trouble produced by *Spongospora subterranea*. Until this paper, it had been generally assumed on the basis of a paper by Miss M. N. Owen (*Kew Bulletin*, 1919, pp. 289-301) that skin spot was due to quite a different organism, a new species of Oospora, named by the discoverer *O. pustulans* Owen and Wakef. As skin spot frequently occurs upon seed tubers of many of the best-known varieties of potatoes, it was obviously of great importance to know whether the organism causing skin spot could also give rise to corky scab, and potato-growers will read with relief the communication by W. A. Millard and Sydney Burr in *Kew Bulletin*, No. 8 for 1923. This work

records the results of inoculation experiments with both *Oospora pustulans* and *Spongospora subterranea*, which confirm Owen's original conclusions completely, and leave no doubt that the first organism is responsible for skin spot and the second for corky scab. Anatomical investigations of the pustules also show clear differences between those of skin spot and of corky scab, and there is no likelihood of a skin spot pustule later masquerading as a typical corky scab. Shapovalov's contrary results were obtained in the United States, and Millard and Burr are therefore led to make the suggestion, inevitably suggested by their own work, that except when the American author examined diseased tubers sent from Europe, he never had typical skin spot under observation.

VARIATIONS IN LEVEL OF LAKE VICTORIA NYANZA.—Attention was directed in 1904 to the remarkable variations in the level of the Victoria Nyanza by Col. Lyons, who attributed some of them to differential movements in the adjacent land. The general oscillation of the level in that lake and in the Albert Nyanza is described by Mr. C. E. P. Brooks in a Geophysical Memoir, No. 20, issued by the Meteorological Office (1923; 8 pp., 1 pl.; price, 1*s*. 6*d*.). Mr. Brooks describes the variations in the lake levels as recorded by tide gauges on the Victoria Nyanza from 1896 to 1922 and on the Albert Nyanza from 1904 to 1922, and compares the rise and fall of the lakes with the variations in sunspots and rainfall. The discharge from the Victoria Nyanza over the Ripon Falls is estimated at only 6 per cent. of the rainfall on the basin of the lake. Most of the rain is removed from the basin by evaporation, which Mr. Brooks regards as highest during periods of sunspot minima, so that the lake level is then normally lowest. He claims that the lake levels accord more closely with variations of sunspots than with those of rainfall. He points out in illustration of this view that the great rise in the level of the two lakes in 1917 was "entirely unconnected with any increase in the rainfall." The curves on the plate illustrating the memoir show a general agreement of the sunspot minima with the lake levels: but the agreement is not complete, for the sudden rise in 1901 followed an increase in rainfall but without any equivalent movement in the sunspot curve. There was a similar disagreement in 1913, and moreover, the high level of the Victoria Nyanza in 1906 preceded instead of followed the sunspot maximum of 1907.

SPACE FORMULÆ OF BENZENE, NAPHTHALENE, AND ANTHRACENE.—The carbon atoms of the benzene molecule are shown by B. Orelkin (Jour. Russ. Phys.-Chem. Soc., 1923, 54, pp. 493-532) to be situated at the corners of a regular octahedron. This conclusion is arrived at from geometrical considerations, which show that the above arrangement of the carbon atoms is the only one in which the thirty valency electrons of the benzene molecule can form a stable system. In support of this formula it is claimed that it explains why more or less than six carbon atoms cannot form an aromatic nucleus. The properties of the aromatic nucleus are explained as due to the peculiar arrangement of valency electrons around the carbon atoms, whereby each of the latter possesses two electrons in common with its neighbours. Sachs found that the relative distances of the *o*-, *m*-, and *p*- positions were as $1 : \sqrt{2} : \sqrt{3}$, and the same proportion is shown to hold for the formula now deduced. The space formulæ of naphthalene, anthracene, and chrysene are obtained by the condensation of two, three, and four benzene nuclei, and the angles of the space lattices of crystals of these substances are calculated from their molecular structure. These calculated values agree very closely with experimental values obtained by other workers.

LOW-TEMPERATURE CARBONISATION OF COAL.—The Fuel Research Board of the Department of Scientific and Industrial Research has just issued a Technical Paper No. 7 on "Preliminary Experiments in the Low-temperature Carbonisation of Coal in Vertical Retorts" (H.M. Stationery Office, 10*d*. post free). The paper may usefully be read in continuation of the report of the same body for the years 1920 and 1921, analysing the technical and economic problems to be faced in establishing a British industry of low-temperature carbonisation. The necessity for low operating costs, therein emphasised, implies a minimum of manual labour, and the use of the continuous vertical retort is one way of attaining this. An installation of such retorts on the Glover-West system now exists at the Fuel Research Station, Greenwich. Though designed for working under the high temperature conditions now current in towns' gas works, they have been employed in carbonisation trials, now reported, in which low working temperatures were maintained. The setting is ill adapted for securing the best results under such conditions, but the tests—admittedly of an exploratory character—have been carried out to obtain information likely to assist in the design of more suitable retorts. Such retorts have been constructed and trials are to be carried out in them. In the present tests flue temperatures ranged from 700° to 850° C., and it was found advantageous to inject steam into the retort, both to cool the coke and to assist in distributing heat through the charge. A coke was obtained containing about 7 per cent. of volatile matter and said to be suitable for use in domestic grates. The high proportion of breeze in the coke suggests trouble and loss in transportation. Per ton of coal, there was obtained a yield of 12-16 gallons of tar having a "low temperature" character and 18-28 lb. of ammonium sulphate. The yield of gas was only 45-50 therms per ton—very low from the gas-maker's point of view and fatal to commercial success unless the coke realised a very high price. As no finality is claimed for these results, the results from the new retorts will be awaited with interest.

HEAT LOSSES THROUGH HOUSE WALLS.—The Building Research Board of the Research Department has issued, as Special Report No. 7, accounts of the tests carried out at the National Physical Laboratory of the heat transmitted through walls of various types when one surface is hotter than the other, of those made in Norway on the heat insulating properties of the walls of experimental huts constructed in more than 20 different ways in use in that country, and of similar tests carried out in Sweden and in Germany. So far as the British tests have been conducted, they show that a solid gravel concrete wall and a wall of sand-lime bricks transmit about the same amount of heat under the same conditions, but that a wall of stock bricks only transmits about $\frac{3}{4}$ as much heat. A cavity wall of ordinary type transmits about $\frac{1}{2}$ to $\frac{5}{8}$ that of a solid wall according to the size of the cavity. The Norwegian results include the cost of construction and show in a remarkable way the low heat transmission through the less costly wooden walls of various types common in that country. Where cavity walls are used the best arrangement is to place the thicker portion in the interior. The Swedish results, so far as they go, confirm the above conclusions. The German results have led to a subdivision of the air cavity between thin concrete walls into six or more layers by means of paste-boards.

Scientific Exhibition at British Association Meeting.

THE ninety-first annual meeting of the British Association, which has just drawn to a close at Liverpool, was characterised by a new and important departure in the form of an exhibition of scientific apparatus, instruments, and diagrams. The exhibition was on the lines of that organised each year in London by the Physical and Optical Societies, which is so effective in bringing together the users and makers of physical apparatus, but its scope was naturally wider, and many branches of pure and applied science were represented.

In opening the exhibition on Monday, September 10, Sir Charles Sherrington commented upon the comprehensive and representative character of the exhibits, remarking that it was very appropriate that such a collection should be brought together, and that this—the first of its kind—constituted a definite development in the history of the British Association. He further referred to the remarkable advances in the making of scientific instruments during the last three hundred years, to the ever-growing importance of instrumentation, and to the unavoidable complexity of the apparatus needed for some of the simplest and therefore the most fundamental of scientific inquiries.

Admission to the exhibition was not confined to members of the British Association, to whom it was free, but the doors were opened to any member of the public on payment of the moderate sum of one shilling for one day only, while three times that amount guaranteed admission at any time during the fortnight of the exhibition. The results for the first week show that this arrangement was happily inspired, and that the exhibition was as popular with the outside public as with members of the Association. The number of daily tickets sold was quite naturally largely in excess of the number of season tickets, but the demand for the latter was quite sufficient to justify their issue.

The exhibition committee was fortunate indeed in having at its disposal the excellent accommodation afforded by the Central Technical Schools, Byrom Street, and the exhibits occupied the rooms on three floors of this magnificent building. The fine lecture hall enabled daily lectures, in some cases illustrated by cinematograph films or experiments, to be given by men of science, a feature which contributed in no small degree to the success of the exhibition. The popularity of these lectures is sufficiently illustrated by the fact that arrangements were made for two at least to be delivered a second time—"The Optophone," by Prof. Barr, and "Researches in Special Steels," by Mr. S. A. Main (Research Department of Sir Robert Hadfield's, Ltd.). Other lectures included "Ripples," by Prof. L. R. Wilberforce; "Research and Industry," by Sir Frank Heath; "Experiments on Coal Dust Explosions in Mines," by Prof. H. B. Dixon; "The Compass in Navigation," by Capt. Creagh-Osborne, R.N.; "Flame," by Prof. A. Smithells; "Kodachrome Cinematograph," by Dr. Mees (Kodak Co., London); "Developments in Wireless Telegraphy," by Commander Slee (Marconi Co., London).

Much attention was attracted by demonstrations, daily throughout the meeting, of the photophone exhibited by Prof. A. O. Rankine, and the optophone (Barr and Stroud, Ltd.). In the former, the transmitter or light modulator was installed in a room in St. George's Hall, and the beam of light, fluctuating in sympathy with the vibrations constituting the sounds to be transmitted, was thrown across the intervening space of some two hundred yards to the room in the Central Technical Schools where the receiving apparatus was located. The fluctuating light here controlled the electric current in a selenium cell, and the variable current actuated a telephone receiver. In this way demonstrations were given of the transmission of speech and music, and these made, in particular, a wide appeal to the lay mind, a result largely assisted by publicity given by the Press.

No less popular were the demonstrations of the optophone, the purpose of which is to enable the blind to read ordinary printed matter. In this, a selenium bridge is exposed to successions of sets of light pulsations, which vary with the forms of the letters passed over. Characteristic musical sounds are produced in a telephone receiver by each letter, constituting an alphabet readily learned.

The exhibition committee received the support of the National Physical Laboratory and of the Meteorological Office, Air Ministry. The exhibit of the former consisted very appropriately of specimen lenses for use in ships' lights, and master standards of colour for testing the colour screens of ships' lights. These were in accordance with the recommendations made in the Report of the Departmental Committee on Ships' Navigation Lights (1922), and formed an instructive display..

The exhibit provided by the Meteorological Department of the Air Ministry followed closely the lines of demonstrations given by that department at the two previous meetings of the Association, in Hull and Edinburgh. A wireless receiving set was employed to intercept the broadcast messages forming the daily international exchange of weather information, and, from these, weather charts were prepared, and forecasts made for the Liverpool area and the Irish Sea. Visitors were, in fact, able to see in miniature the complete working of a weather forecast service. These demonstrations were supplemented by a display of up-to-date meteorological instruments, and by diagrams and photographs of geophysical interest. Much interest was shown in the record of the recent earthquake in Japan, taken at the Bidston Observatory, and in a set of charts showing the progress of the depression which caused the destructive gales of August 29–30 of this year. One of these charts showed the depression completely defined over the Atlantic by one of the best sets of simultaneous observations from ships ever received in the Meteorological Office, and the accuracy of the forecasts issued on that occasion emphasises the practical importance of such reports.

One impression gained by a visit to the exhibition was that the field covered by the exhibits was not only a wide one, but also that very great care had been exercised in the choice of the material shown, having regard to the position of Liverpool as a great seaport and its location in an industrial area. It is not possible to deal in detail with the many interesting and instructive things which were to be seen, comprising, as they did, many striking exhibits in wireless transmission, in the manufacture of steel, in optical and electrical instruments, in instruments employed in navigation, including the gyro-compass, in the chemical and dye industries, in the manufacture of glass, in chemical apparatus, in recorders for use in the control of fuel combustion, in photography and photomicrography, in meteorological instruments, and in other branches of science and industry. Among the instruments which attracted special attention was K. C. Cox's selenium magnifier (H. W. Sullivan, Ltd.), which was shown working in connexion with a syphon recorder for long-distance submarine cable signalling, and is capable of giving magnification up to ten

thousand times the received signal, and higher in special cases. New wireless apparatus, shown by the Marconi International Marine Communication Co., Ltd., embraced direction finders for use in ships, a special installation for ships' lifeboats including direction-finding equipment, and a duplex telephone set—designed to enable ships within 50 miles of land to communicate by telephony with offices on land, utilising on land the ordinary telephone installation. The last is at present under trial at Southampton in co-operation with the General Post Office. Other very recent apparatus included a small X-ray spectrograph (Adam Hilger, Ltd.), made to the design of Dr. A. Müller, embodying details valuable for the analysis by crystal structure of crystals and powders, and a barograph of special construction for survey work (by Negretti and Zambra). The latter has a range of 4 inches on the chart to represent 1 inch variation of barometric pressure, and the instrument can be set to a standard barometer, anywhere from 25 in. to 31 in. of mercury, the temperature compensation being effective over this range. Mr. S. G. Brown's frenophone was another exhibit on which attention was focussed. This is a new "loud speaker" in which magnification of sound is obtained by an ingenious mechanical device dependent on the great friction existing between cork and glass.

But, in the space of a short article, justice cannot be done to all the interesting and instructive exhibits contained in the convenient and well-illustrated handbook issued by the exhibition committee. The local officers of the Association, the exhibition committee, and, in particular, the chairman of the committee, Capt. F. W. Bain, are to be congratulated on the success of this new departure, and it is to be hoped that they may be rewarded by seeing the present exhibition as the first of a long series in future years.

M. A. GIBLETT.

Terrestrial Magnetism in France.[1]

A DECREE of July 28, 1921, created an Institute of Geophysics attached to the Faculty of Science of the University of Paris, and the new institute has assigned to it the work in terrestrial magnetism previously entrusted to the Meteorological Service. There was established at the same time a Central Bureau of Terrestrial Magnetism for France and her colonies. The director of both bodies is the editor of the volume under notice, Prof. Ch. Maurain. He contributes an historical account of magnetic observations in France, and a study of disturbances due to electric traction. Recent magnetic history in France, as elsewhere, is mainly a tale of the devastating effects of electric traction. Parc St. Maur, which commenced its career as a magnetic observatory in 1883, had to be replaced in 1901 by Val Joyeux, and fears are now entertained for the future of Val Joyeux. There are already two electric lines in the district, one coming within 4400 metres, the other within 3000 metres of the observatory.

A discussion by M. Baldet of observations made at Berizaréa in Algeria represents magnetic work done in the colonies. The greater part of the volume, pp. 38-249, is, however, devoted to a discussion by M. Ch. Dufour of the magnetic observations at Val Joyeux from 1915 to 1921. This practically represents seven years' work rolled into one. In the earlier part of the memoir the results of the same species for the seven years appear in immediate succession. Thus we have 9½ consecutive pages of Fourier coefficients for the diurnal variation of D (declination) and H (horizontal force) calculated for every month from January 1915 to December 1921, while pp. 60-94 are devoted to a description of the magnetic disturbances recorded during the 84 successive months. The principal magnetic storms are dealt with in 23 plates at the end of the volume, Z (vertical force) curves being reproduced as well as D and H. The time scale is only 1 cm. to the hour, and details of rapid oscillations are difficult to follow, especially for the largest storms, among which the storm of May 14-15, 1921, is pre-eminent. A rather unusual feature is that movement up the sheet represents decrease in all three elements. On p. 95 is a résumé of mean absolute values of seven elements at Val Joyeux from 1901 to 1921. The plan of the work then alters, the years being treated separately. The material given for each year has some special features. There are, first, for each month mean daily values for D, H, and Z, and hourly values confined to 6h, 12h, 18h, and 24h. The absolute daily maximum and minimum of D and their times of occurrence are included, and a word or two describes the character of the day. Then follow diurnal inequalities for the 12 months, apparently from all days, for 7 elements, and a table containing mean values for the 24 hours of the representative day of the year, derived respectively from all days and from quiet days. Following this is a most elaborate presentation of results from the five international quiet days of each month. Absolute values are given for each hour of each day for six elements.

The last part of the volume, pp. 250-298, contains a most valuable discussion of the magnetic results at Parc St. Maur and Val Joyeux from 1883 onwards by the veteran magnetician, M. A. Angot, late director of the Meteorological Bureau. This is a perfect mine of information for the magnetician. We have first diurnal inequalities for D, H, Z, and I (inclination) for the twelve months, derived independently from 18 years' records at Parc St. Maur, and from 17 years' records at Val Joyeux, stations both in the neighbourhood of Paris. Then we have diurnal inequalities for seven elements based on the whole 35 years, and ascribed to Paris. Following this there are Fourier coefficients for the 24-, 12-, 8-, and 6-hour waves corresponding to these inequalities. An elaborate investigation is made into the possibility of representing the annual change in the amplitude and phase of the several Fourier waves in terms of the longitude of the sun in its apparent annual path.

Another question minutely considered is the annual variation, meaning thereby the variation left in the mean monthly values of the elements after the elimination of the secular changes, assumed to progress at a uniform rate throughout the year. Use is made of mean monthly values of seven elements from 1883 to 1920, recorded in tables on pp. 278-284. The range obtained for the annual inequality in D, 0·23′, seems the smallest found anywhere as yet, but a suspicious feature in previous results has been the tendency for the apparent range to diminish as the number of years available has increased. For most of the other elements there are quite substantial ranges, *e.g.* 0·80′ in I (maximum in November, minimum in June), and 17·3γ in H (maximum in June, minimum in November). The ranges for these two elements are somewhat larger than those found for Kew[2] from a shorter period of years, but the

[1] Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme Terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome Premier. (Paris: Les Presses universitaires de France, 1923.)

[2] Roy. Soc. Phil. Trans., vol. 216, p. 238.

maximum and minimum occur in the same months at the two stations.

A very complete investigation follows into the secular change, based on a table, on p. 287, of mean annual values at Parc St. Maur reduced to Val Joyeux, and at Val Joyeux, extending from 1883 to 1921. Some small differences may be noticed from M. Dufour's table on p. 95. On p. 288 reference is made to the possible influence of sunspots on secular change. As several magneticians have supposed such an influence to exist, it is important to note that M. Angot's results are wholly negative: "il semble impossible de retrouver . . . la moindre trace d'une périodicité de onze années." Secular change has followed almost identical courses at Paris and London. The change of D in late years has been very rapid, the easterly movement at Paris from 1916 to 1921 being 48·1′. H attained a maximum in Paris in 1912. After falling continuously until 1913, I has been rather oscillatory, there being a rise from 1914 to 1918, but a fall since.

As a final contribution to the subject of secular change, M. Angot has tried to represent the value of D at Paris from 1541 to 1921 by a simple harmonic fluctuation about a mean value. The formula giving the best results is

$$D = 6{\cdot}55^\circ + 15{\cdot}85^\circ \cos 2\pi(t - 1814)/480,$$

t being the date in years. The agreement between this formula and observation is quite good from 1541 to 1891; but since 1881 the excess of the observed westerly declination over that calculated has steadily increased until in 1921 it was 3·2°. The publication of this volume promises well for the future of the new Institute of Geophysics of the University of Paris.

C. CHREE.

University and Educational Intelligence.

THE Department of Aeronautics of the Imperial College of Science and Technology, which was established in 1920–21, has issued a pamphlet showing the courses available during the session 1923–24. The work is conducted in three sections, design and engineering, meteorology, and navigation, and a complete course normally occupies two years, the second often including research and experimental work.

THE university extension division of the University of Colorado exemplifies the wide range of services offered by a modern state university in America. This "division," described as "simply a vehicle by means of which the various departments of the university may be made available to the people of Colorado," includes not only a department of instruction (correspondence, class, vocational, and visual), but also a "department of public service" comprising bureaus of community organisation (for promoting public health, child welfare, recreation, and kindred subjects), business and governmental research, library extension, home-reading courses, high school debating league, high school visitation, and supply of public speakers. The range of public service which the university is willing to undertake is, in fact, limited only by its capacity to perform them.

FOR many years an admirable system of continuative education has been given in Great Britain in H.M. Dockyard Schools. Boys enter the dockyards as the result of competition, and the effect of this is a high standard of teaching in the primary and secondary schools of dockyard towns. When the apprentice has entered the dockyard, he has to attend school for eleven hours each week, partly in the afternoons in his working hours, and partly in the evenings. He is under strict naval discipline during these educational periods, and absence from school without sufficient cause leads to loss of pay, or to suspension or dismissal if the offence is repeated. Attendance is compulsory for every apprentice in the first year, but at the end of each of the four years of the normal course the least successful students are sent away from school. There is thus a continual weeding out of the mentally unfit, with the result that, at the end of the fourth year, the students who remain represent the best products of a wise combination of theoretical and practical training and are able to compete successfully for any scholarships in which applied science and mathematics are given prominence. The announcement of the result of this year's competition for Whitworth senior scholarships and Whitworth scholarships affords a remarkable example of this fact. The number of competitors for the former—of an annual value of 250*l.* tenable for two years—was 19, and for the latter—annual value of 125*l.* tenable for three years—was 142. Of the two senior scholarships awarded, one was to a former dockyard apprentice, now at the Royal Naval College, Greenwich. Of the six other scholarships, four were awarded to dockyard apprentices, and of the twenty-five Whitworth prizes of 10*l.* each given to unsuccessful candidates, twenty-one were awarded to dockyard apprentices. These splendid results are most creditable to the instructors in H.M. Dockyard Schools, and they show that the Admiralty system of education is a potent force for technical training and development in Great Britain.

THE prospectus for 1923–24 of university courses in the Manchester Municipal College of Technology contains the new regulations for the B.Sc. Tech., which provide for higher courses, distinct from, and at least one year in advance of, the ordinary degree courses, to extend over three years from the standard of the present intermediate examination for the degree, or the Higher School Certificate. The college offers courses of post-graduation and specialised study and research in various branches of engineering, applied chemistry and chemical technology, textile industries, applied physics, and mining engineering. The calendar of the Merchant Venturers' Technical College, Bristol, gives particulars of university degree courses, including the Bristol "sandwich" scheme of training for engineers. This comprises three periods of ten months each in the university, followed severally, the first by 14, the second by 2, and the third by 14 months in certain engineering works to which the university undertakes to recommend suitable students. Loughborough College, which has on its Board of Governors representatives of the Universities of Cambridge and Birmingham as well as of the Leicestershire County and Loughborough Town Councils, publishes full details of its equipment and courses in engineering and chemical technology and of its School of Industrial and Fine Art, Junior College, and extra-mural department, together with a list of some 250 students who qualified in 1922 for the College diploma, conferred for the first time in that year. The diploma course covers five years and its special feature is that, unlike the various "sandwich" systems, it provides for continuously concurrent training in engineering theory and practice. The Sir John Cass Technical Institute, London, announces, among others, special courses of higher technological instruction in brewing and allied industries, petroleum technology, colloids, alternating currents and electrical oscillations, metallography, foundry practice, mining and surveying.

Societies and Academies.

PARIS.

Academy of Sciences, August 27.—M. A. d'Arsonval in the chair.—Jean **Perrin**: Observations on fluorescence. The fluorescence of a solution depends on its concentration, thickness of layer, and light-absorbing power of the solvent. An attempt is made to define specific fluorescence, measurable by a coefficient independent of these factors.—D. **Mordouhay-Boltovsky**: Certain categories of transcendental numbers.—Jules **Baillaud**: The astronomical station of the Pic du Midi. This observatory is characterised by the purity of the sky and clear images. The advantage of the height (2870 metres) is not obtained at the price of undue fatigue on the part of the workers. Observations would appear to be possible except during the late winter and spring months.—A. A. **Guntz**: Phosphorescent sulphide of zinc. The partial substitution of cadmium sulphide in the zinc sulphide gives a more durable phosphorescence and causes changes in the colour of the light. It also renders the phosphorescent sulphides more easy to insolate.—André **Charriou**: The absorption of sodium hyposulphite by photographic papers. The elimination of sodium hyposulphite from photographic papers is much more rapid and complete, if the washing is carried out with solutions of sodium or ammonium bicarbonate instead of with water.—Ch. **Kilian** and V. **Likhité**: The development of *Hendersonia foliorum*.—Maurice **Piettre**: The chemical relations between humic materials and coal.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 9, No. 8, August 1923).—C. **Barus**: (1) The vibration of air in tubes capped at both ends. The air columns are actuated by telephones. Pressure changes are measured by an interferometer U-tube. With H-tubes and straight tubes there is a frictional but no special frequency effect. (2) The vibration of the air filament in quill tubes capped at both ends.—J. P. **Minton** and J. G. **Wilson**: Correlation between physical and medical findings on normal ears. Curves showing the relation between the root mean square pressures exerted on the ear drum by a telephone receiver diaphragm, plotted on a logarithmic scale, and the frequencies, plotted on a linear frequency scale, are used. In most of the fifty-four cases cited, the physical and medical findings for normality of the ear are in agreement.—T. Y. **Thomas**: The Einstein equations of the gravitational field for an arbitrary distribution of matter.—W. T. **Councilman**: The root system of *Epigæa repens* and its relation to the fungi of the humus. The roots of this member of the Ericaceæ, which is found only in America and Japan, are devoid of roothairs; the place of the latter appears to be taken by the hyphæ of a fungus which penetrate between and into the cells of the roots. The roots break up into a number of fine capillaries which ramify the humus near the surface of the soil. The relationship appears to be one of symbiosis.—J. V. **Leech**: The symmetry of the internal ears in flatfishes. Although the left eye of flatfish migrates during development until it comes to lie beside the right eye, the left ear remains in its original position. Examination of the left and right ears of numerous specimens of *Pseudopleuronectes americanus* and *Limanda ferruginea* showed no difference in structure. In consequence, the mode of action of the ears of these fish in equilibration is difficult to understand.—A. **Bramley**: Motion of an electric particle in a Riemann space. An infinitesimal particle revolving about the atomic nucleus describes a definite orbit with constant velocity.—W. M. **Davis**: (1) The marginal belts of the coral seas. The islands in the Pacific, in addition to the formerly glaciated islands of the colder seas, can be grouped in three categories: (*a*) Volcanic islands with cliffs, generally without submarine banks or coral reefs and mostly in the colder seas. (*b*) Islands with cliffs and submarine banks, sometimes with coral reefs; an intermediate or marginal belt about 5° wide between latitudes 25° and 30° north and south of the equator. (*c*) Volcanic islands without cliffs but having lagoons rimmed by coral reefs. The data supports the postulate of unstable islands associated with changes of ocean level and temperature, *i.e.* Darwin's theory modified by glacial control factors. (2) The depth of coral-reef lagoons. The stable rock platform hypothesis for the foundation of atolls is rejected on the grounds of the absence of cliffs and of such platforms on islands thought to represent uplifted atolls. Lagoon-enclosing reefs on subsiding foundations would produce lagoons of moderate depth; increased rate of subsidence would be counterbalanced by increased inwash of detritus. Shallow pre-glacial lagoons would be deepened by continued degradation during the lowering of the glacial ocean. The subsidence theory also accounts for submarine banks at varying depths in the coral seas.

SYDNEY.

Linnean Society of New South Wales, July 25.—Mr. A. F. Basset Hull, president, in the chair.—R. H. **Anderson**: A revision of the Australian species of the genus Bassia. Forty-two species of the genus Bassia are discussed, of which nine are described as new, and four as new combinations. A key to all the Australian species is given.—Jessie K. **Steel**: Anatomical features of the mature sporophyte of *Selaginella uliginosa*. The species is primitive. The radial type of shoots, together with the frequent occurrence of a Selago condition, the mixed arrangement of the sporangia in the cones, and the presence of four megaspores within the megasporangium, all point to a close relationship with the more primitive members of the Lycopodiales.—C. **Hedley**: Studies on Australian Mollusca. Pt. xiv. New species of the genera Hemidonax, Pitaria, and Umbraculum are described. From the Great Barrier Reef a considerable body of species is noted, which were named from New Caledonia and have now extended to Australia.

Official Publications Received.

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1919. Part 3: Meteorological Observations made at the Secondary Stations during the Calendar Year 1919. Pp. 357. (Manila: Bureau of Printing.)

Northampton Polytechnic Institute, St. John Street, London, E.C. Educational Announcements (Evening only) for the Session 1923-1924. Pp. 81-232. (London.)

Department of Commerce: Bureau of Standards. Scientific Paper No. 474: Series in the Arc Spectrum of Molybdenum. Pp. 113-129. (Washington: Government Printing Office, 1923.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 17: Educational Surveys. By Prof. Edward Franklin Buchner. Pp. 44. Bulletin, 1923, No. 24: Educational Extension. By Charles G. Maphis. Pp. 32. Bulletin, 1923, No. 26: Educational Work of the Young Women's Christian Association. By Education and Research Division, National Board of Y.W.C.A. Pp. 24. (Washington: Government Printing Office.) 5 cents each.

Report on the Zoological Survey of India for the Years 1920 to 1923. Pp. lvi. (Calcutta: Government Printing Office.) 1 rupee: 2*s*.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Grenada, January-December 1922. Pp. iv+14. (Trinidad.) 6*d*.

Transvaal University College (University of South Africa). Calendar 1923. Pp. 270+6 plates. (Pretoria.)

Ministère de l'Instruction publique et des Beaux-Arts. Enquêtes et documents relatifs à l'enseignement supérieur. 118: Rapports sur les observatoires astronomiques de Province. Année 1922. Pp. 130. (Paris: Imprimerie Nationale.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1922. Par M. B. Baillaud. Pp. 32. (Paris: Imprimerie Nationale.)