THURSDAY, SEPTEMBER 15, 1921.

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

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

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

Cholera Risks.

RECENT Press telegrams emphasise Poland's struggle to resist the tide of infection of typhus, small-pox, and cholera which is rolling up from Russia, while the *Times* announces that the Mecca pilgrimage has been declared free from cholera, and the work of the International Quarantine Board, shortly to be absorbed into the Public Health Department, is eulogised, and its possibilities of co-operation to protect the world from the Russian cholera danger are stated.

The association of famine, like that of war, with great outbreaks of epidemic disease is well known. The exigencies of both war and famine commonly mean the aggregation and a vastly enhanced movement of masses of people, thus greatly increasing the likelihood of transmission of infection at a time when the possibility of precautionary measures is reduced to a minimum. This general problem is of great interest both historically and in connection with current events.

The terrible ravages of typhus in Russia, Poland, and Serbia during the war and since its formal termination are well known, and its almost complete absence from the ranks of the Western belligerents is striking evidence of possibilities of prevention when there is a background of civilian behind the military sanitary administration. Small-pox similarly has been kept under control, and sanitary measures and anti-typhoid inoculations have made typhoid fever a shadow of its former self.

Against cholera a country in a most backward condition as regards the elementary sanitation of water supplies and sewerage is almost helpless, and the chaos of practical anarchy adds to its difficulties. It is this conjunction of events which makes Russia a source of danger, not only to Germany and Poland, its immediate neighbours, but also to a less extent to Europe generally, and even to America, so soon as frequent human intercommunications are established.

Assuming that no efficient action is likely to be taken in Russia itself, the possibilities of preventing importation and of obviating the spread of imported infection of cholera vary according to the country concerned. In a country like Poland, recently reconstructed out of several nationalities and with hastily improvised organisation, the difficulties are exceptionally great. The history of cholera in Poland this autumn, and still more next summer, will depend chiefly on the extent to which the water supplies of its towns and villages are liable to specific contamination by human choleraic discharges. It is not surprising to learn that in Russian refugee camps mass inoculation against cholera has been begun. This measure is still in its infancy, and the personal immunity thus secured is relatively short. We need not be surprised, therefore, to learn, in the early future, of attempts at land quarantine, which in the past has never succeeded in preventing the importation of infection. This has been shown both in European and American experience; one American hygienist compares attempts at inland quarantine to *delirium ferox* in the scale of insanity. Such quarantine has always been incoherent, uncertain in administration, a source of friction and interference with trade, without commensurate sanitary gain. It is important, of course, to supervise the medical condition of immigrants from infected localities and to keep them under surveillance if their condition is suspicious, but to take similar action for large masses of population or for a prolonged period is foredoomed to failure.

Similar remarks apply partially to efforts of maritime quarantine. When rigidly enforced it has embarrassed commerce, and has not succeeded. Even in the case of immigrants arriving in American ports from Europe, the failures to prevent the importation of cholera by rigid quarantine at the port of arrival have been conspicuous. In infected neighbourhoods in Manila 6 to 7 per cent. of healthy individuals were found to be "carriers" of cholera bacilli in their intestinal contents, and when we note that these bacilli may be harboured for as long as sixty-nine days it is easy to understand how quarantines may be passed and apparently inexplicable outbreaks may occur.

The question arises as to whether in practical administration it is possible to examine the rectal contents of all immigrants before allowing them to proceed to their destination. This has been done partially both in Egyptian and in American administration, and on a small scale this application of Koch's discovery in 1883 of the comma-bacillus of cholera is practicable. On a large scale it fails, for reasons which need not be amplified here.

In actual fact the wisdom of the English system of trusting to medical inspection and detention of actual patients and suspected patients at the port of entry, and of trusting still more to the local sanitary machinery in each division of the country, has been justified by long experience. Quarantine is an elaborate system of leakiness, as has been shown by the experience of all invaded countries. In 1831 every country in Europe was invaded by cholera despite all efforts to keep it out. In 1849, 1853, and 1865–66 this experience was repeated in England, though on these occasions no attempt hermetically to seal the ports was made.

It took Simon and his colleagues in the Privy Council, the Board of Health, and the Local Government Board, the successive central health authorities of England, twenty-five years to make any impression on other countries in favour of the abolition of the futile and oppressive measures of quarantine, and the substitution of medical inspection for detention, followed by local supervision; but these principles have now become generally adopted in settled countries with adequate sanitary administration, and it has become recognised that trust in quarantine gives a false security, and, furthermore, delays the adoption of the internal measures of general sanitary administration both as to *personnel* and water supplies, on which reliance must chiefly be placed.

There need be no fear of a serious outbreak of cholera in this country, even if occasional cases of the disease evade the meshes of medical inspection and supervision. Such exceptional cases might by personal infection or by infecting articles of food even produce small local outbreaks; but this is unlikely, and if it should occur public health administration in every part of this country is equal to the task of suppressing an outbreak, whether of cholera, or typhus, or small-pox.

The Human Factor.

An Introduction to the Psychological Problems of Industry. By F. Watts. Pp. 240. (London: George Allen and Unwin, Ltd., 1921.) 12*s.* 6*d.* net.

THE fact that our industrial system has a human, as well as a material, side has been brought prominently into view in recent times, and it is beginning to be recognised clearly that no perfect or satisfactory industrial system can be attained along the road of purely material progress. Hence industrialists all over the world who have hitherto had their eyes turned wholly on physical science as the main source from which contributions to industrial progress were to be expected are now turning their eyes towards the sister science of psychology so long neglected and misunderstood. Fortunately, the latter science has, within the last generation, been developed in a direction and to a point which make it possible for the psychologist to meet—at least partially—the claims thus coming upon him from a new quarter. Psychology, no longer the science which confines its study to mental process in the individual mind, but the science which studies the behaviour of all living organisms, is now fully conscious of its practical significance and of its duty to the worker in every sphere of activity.

This changed outlook, both in industry and in psychology, is exemplified by the work of the scientific-management engineers, on the one hand, and the number of recent books on industrial psychology written by professed psychologists on the other. Münsterberg, Swift, Hollingworth, Myers, Muscio, and others have already produced a fairly extensive literature in this new field. The latest book of this kind, and one of the most interesting and suggestive, is Mr. Frank Watts's "Introduction to the Psychological Problems of Industry." While generally similar to the other existing books on the same subject, Mr. Watts's work has also certain important characteristics of its own which are worthy of something more than mere passing notice.

The chapter headings indicate the line of thought pursued—"The Psychological Point of View in Industry," "Industrial Fatigue and Inefficiency," "Vocational Selection," "Industrial Unrest," and so on. It will be noted that the author by no means confines himself to the various problems of the factory which can be experimentally studied by the methods of the experimental laboratory. In fact this, the chief part of most other works on the same subject, is a relatively minor part of the book before us. Vocational selection, for example, is treated very briefly and, on the whole, rather slightingly. This is really the only serious blemish on a valuable piece of work, a blemish which is scarcely removed by a promise in a footnote to deal with the subject of vocational selection in another book to be published shortly. This defect is, however, in our opinion, compensated by the very interesting discussion from a psychological point of view of some of the larger and more pressing problems of labour, beginning with chap. v. on "Scientific Management and Labour," and continued in chap. vi. on "Industrial Unrest," the most important chapter in the book.

Mr. Watts has made a serious and, on the whole, very successful attempt to apply the newer psychology of human tendencies and emotions—the psychology of McDougall, Trotter, Freud, and Jung—to the conditions and problems of industrial life. The attempt is all the more deserving of attention because it is the most elaborate attempt that has hitherto been made, in this country at least, though Myers, Muscio, and Tead have all made pioneer journeys into this field. The use made of the Freudian psychology to interpret the phenomena of social unrest is particularly noticeable. The analogy between the individual and society is a very old one, but this is the first attempt we have come across to work out the analogy in any detail in the sphere of psychopathology. It need scarcely be said that due caution must be exercised in such an undertaking, and that the analogy easily breaks down if it is pressed. Nevertheless, Mr. Watts must be congratulated on the skilful manner in which he has carried out a difficult task, and the very important and suggestive results to which he has been led.

Early in the book the author points out that there has been, and is still, a good deal of scepticism about the practical possibilities of psychology, more especially, perhaps, in the sphere of industry. In his opinion this scepticism is due largely to the fact that the psychologist has been "too frequently unwilling to quit the enclosures of a narrow specialism, and adventure into the fields of public controversy, there to pass judgment in his own way on current tendencies in art, religion, industry, and politics." This aloofness from the concerns of practical life can no longer be charged against the psychologist. All kinds of significant developments are taking place at the present time in every direction of practical activity, pointing to a growing appreciation of the practical significance of psychology; but surely the charge against the psychologist is an error. The psychologists of an earlier day, in this as in other countries, have been as ready to express their opinions on the questions of the day as have the representatives of the physical sciences. The real reason for the scepticism is that the older psychology was not capable of throwing any very clear or definite light on practical problems, and practical men are only now beginning to be convinced that the newer psychology is in a somewhat different position. Books like that of Mr. Watts's will give a strong stimulus to the spread of this conviction. From this point of view it is of quite exceptional interest and importance.

J. D.

History of Science in Edinburgh.

Edinburgh's Place in Scientific Progress. Prepared for the Edinburgh Meeting of the British Association by the Local Editorial Committee. Pp. xvi+263. (Edinburgh and London: W. and R. Chambers, Ltd., 1921.) 6*s*. net.

THE British Association handbook which has been prepared by the Local Editorial Committee differs entirely in scope from what has usually been offered to the members of the Association. With the present high cost of printing it was early decided that it was practically impossible to give anything like a satisfactory presentation of the city as regards its history, its public services, its educational, industrial, and commercial life, and its general plan and architecture, as well as the customary details of the botany, natural history, and geology of the surrounding region. Such a glorified guide-book seemed scarcely called for in a city like Edinburgh, about which so much literature already exists. There is, however, one aspect of Edinburgh life which, as a whole, has been neglected in the many books which have been written concerning the capital of Scotland, and this is the aspect which should appeal especially to members of an Association the aim of which is the advancement of science. It is briefly expressed by the title, "Edinburgh's Place in Scientific Progress."

In this small volume of 263 pages we find a comprehensive epitome of what has been done by Edinburgh men and men trained in Edinburgh schools towards the advancement of science in all its recognised branches. No fewer than twenty-five authors have contributed to the work, each dealing with his or her appropriate section. Of these the majority are connected with the university, either as graduates or members of the teaching staff. A brief glance at the contents will suffice to show the nature of the book.

Section 1, on mathematics and natural philosophy, is by Dr. C. G. Knott, with subsections on astronomy by Prof. Sampson, actuarial science by Dr. A. E. Sprague, and meteorology by Mr. Andrew Watt. Here we find chronicled the important advances made by Napier, Gregory, Stirling, and Maclaurin in mathematics; by Leslie, Forbes, Balfour Stewart, Waterston, Tait, and Maxwell in experimental and mathematical physics; by Buchan in meteorology; by Dr. T. B. Sprague in actuarial science; and by Henderson in astronomy. In section 2 Dr. Dobbin treats of pure chemistry; Principal Laurie of industrial chemistry; and Mr. Steuart of the shale oil industry. Black, Rutherford, and Hope receive particular notice; the share the industrial chemists of Edinburgh took, and still take, in the production of certain important drugs is duly chronicled, and also the remarkable work of James Young in initiating the manufacture of paraffin. Section 3 is devoted to geology, and Messrs. E. B. Bailey and D. Tait, of the Scottish Geological Survey, tell the story of the pioneer work of Hutton, and bring down the record of the work done by Hugh Millar, Maclaren, Traquair, and the Geikies to quite recent days, when botanists and geologists mutually rejoice in the revelations of the fossils of the Rhynie chert.

In section 4, on engineering, Prof. Hudson Beare recounts Symington's early attempts to propel ships with steam power; tells of Nasmyth, of steam-hammer fame; and shows forth the labours of Robert Stevenson and his descendants in designing and building lighthouses and improving lighthouse illumination.

Section 5, zoology, is from the pen of Dr. James Ritchie, who brings out (what is further established by the later articles on botany, geography, and medicine) how greatly the study of natural history was fostered by the teachers and students in Edinburgh's medical schools. The most conspicuous names among these are Edward Forbes, Allman, Wyville Thomson, and Charles Darwin, who spent two years studying natural science at Edinburgh. Although largely a branch of zoology, oceanography is treated as a separate section, and in it Prof. Herdman (himself an Edinburgh graduate) traces the succession of oceanographical developments in Edinburgh through the life labours of Edward Forbes, Wyville Thomson, and John Murray, bringing the story down to W. S. Bruce's *Scotia* expedition and Murray's last voyage in the *Michael Sars*. Section 7, botany, is by Mr. W. W. Smith, of the Royal Botanic Gardens. It is interesting to note that the first chair of medicine in the university was the chair of botany and medicine, and that the founding of this chair followed the institution of the "Medicine Garden," which ultimately developed into the Royal Botanic Garden. Of the many mentioned in connection with Edinburgh, the most conspicuous are Hope, Arnott, Hooker, Graham, Balfour, Robert Brown, and Dickson. A brief subsection on forestry, by Sir John Stirling-Maxwell, emphasises the strong lead taken by Edinburgh in the promotion of forestry as a science.

In section 8, on agriculture, Mr. J. A. S. Watson records the invention of the threshing machine by Meikle, of East Lothian, and the important work done by Shireff in the improvement of cereals. The Edinburgh chair of agriculture, founded in 1790, seems to have been the earliest in any country. Mr. G. G. Chisholm, in the article, "Geography," section 9, begins by giving an impressive list of travellers and explorers who, born or trained in Edinburgh, have notably extended geographical knowledge. A brief history is also given of the two well-known cartographical firms which have brought fame to the city. Section 10 deals with anthropology under the two headings of "Archæology," by Mr. J. H. Cunningham, of the Society of Antiquaries of Scotland, and "Physical Anthropology," by Prof. Robinson. The systematic excavation of ancient sites is now the great feature of archæological research, and the very recent discoveries at Traprain Law have excited great interest. On the other hand, the remarkable collection of skulls and skeletons now in possession of the university anatomical department has been only partially discussed by Turner, Cunningham, and others.

Section 11, on medicine and surgery, constitutes the largest of all the sections, and is the work of three authors, Dr. J. D. Comrie and Prof. Ritchie, treating of the Edinburgh Medical School, and Dr. Alexander Miles, who treats of surgery. The chairs of botany, natural history, and chemistry were all originally chairs in the medical faculty of the university, a fact which explains the valuable work done in pure science by leading Edinburgh physicians and others trained in the medical school; and the same keenness was shown down the centuries in the scientific study of anatomy, physiology, *materia medica*, and other branches of medical and surgical knowledge. The university professors and the teachers in the extramural school alike brought renown to their city as a great centre of medical training. Monro *secundus*, Charles Bell, Benjamin Bell, Sharpey, Goodsir, Christison, James Young Simpson, and Lister are a few of the many whose names are familiar to the student of medicine. In a brief article on dentistry Dr. William Guy pointedly refers to the anatomist Goodsir for his early work on the development of the teeth.

Section 13, on political economy, is contributed by Prof. Nicholson, who leads up through the labours of Adam Smith's predecessors to Adam Smith himself, the great economic genius of all time, and then discusses the work of later economists, such as Macpherson and M'Culloch. Dr. Drever supplies the articles on psychology and education, sections 14 and 15 respectively, in which David Hume, Dugald Stewart, the brothers Combe, Laurie, and Melville Bell find their appropriate places. Finally, in section 16, Miss Nora Milnes describes the social aspects of Sir Robert Philip's anti-tuberculosis dispensary movement and the important part played by Edinburgh authorities in child welfare schemes.

The whole record of scientific work as presented in these contributions to "Edinburgh's Place in Scientific Progress" is one of which any city may well be proud. The work done in Edinburgh and by Edinburgh men does not stand alone, but is closely linked with the labours of men of science in other lands, and it is one of the merits of the book that these international relations are skilfully touched upon by the several writers.

The book is illustrated by portraits of Napier, Black, Hutton, Nasmyth, Edward Forbes, Simpson, Lister, Adam Smith, and David Hume. Intended originally as a handbook for the members of the British Association meeting in Edinburgh, it is being published for general circulation by Messrs. W. and R. Chambers at the price of 6*s*. net.

An Electronic Theory of Valency.

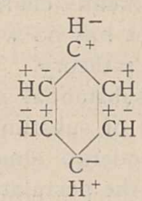
The Electronic Conception of Valence and the Constitution of Benzene. By Prof. H. Shipley Fry. (Monographs on Inorganic and Physical Chemistry.) Pp. xviii + 300. (London: Longmans, Green, and Co., 1921.) 16*s*. net.

PROF. FRY bases his conception of valency on Sir J. J. Thomson's interpretation of the bond (without reference to the nature of chemical affinity or to the structure of the atom) as a unit Faraday tube. Such a bond is produced by the transference of an electron from one atom to another. Furthermore, each atom can both lose and gain electrons, or, in other words, can function as possessing positive and negative valency. Thus a univalent hydrogen atom may function in two ways, as $\overset{+}{H}$ or $\overset{-}{H}$; a bivalent oxygen atom in three ways, $\overset{++}{O}$, $\overset{+-}{O}$, $\overset{--}{O}$; a tervalent atom in four ways; and a quadrivalent atom, such as carbon, in five ways.

On this simple foundation an elaborate system of valency has been built up. It follows from the above assumption that by the combination of two substances X and Y two compounds may be formed—namely, $\overset{+}{X}—\overset{-}{Y}$ and $\overset{-}{X}—\overset{+}{Y}$. These are called electronic isomers, or electromers, and may form an equilibrium mixture. How are they distinguished? The author suggests that if water is composed of $\overset{+}{H}—\overset{-}{OH}$ (though there appears to be no reason why it should not be $\overset{-}{H}—\overset{+}{OH}$) a negative atom or group will attach itself to hydrogen, and a positive atom or group to $\overset{-}{OH}$.

In this way the valency of atoms and groups is determined.

Passing on to part 2 of the work, which deals with aromatic compounds, the electronic formula for benzene is represented as follows:—

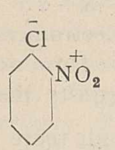


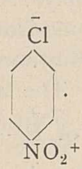
Upon this formula the various reactions of benzene, its physical and chemical properties, as well as those of its homologues and congeners, are based.

It would take up too much space to discuss part 2 in detail, and one or two examples must suffice. It is clear that where substitution takes place a negative atom or group will replace a negative H atom. Here a difficulty appears to arise, for in the case of substitution by chlorine there are two competing atoms in the molecule $\overset{+}{Cl}.\overset{-}{Cl}$. This is met by formulating two electromers, $C_6H_5\overset{-+}{Cl}$ and $C_6H_5\overset{+-}{Cl}$. The author assumes that $\overset{-}{Cl}$ enters the nucleus. It follows, then, that $\overset{+}{Cl}$ has to be satisfied with $\overset{-}{H}$, in which case it is to be presumed that the electromer of hydrogen chloride, $\overset{-+}{HCl}$, is formed. Similarly with nitric acid, which may exist in equilibrium as

$$\overset{-}{HO}.\overset{+}{NO_2} \rightleftharpoons \overset{+}{HO}.\overset{-}{NO_2}.$$

Here the author gives preference to the first formula, whereby NO_2 replaces electropositive hydrogen in the nucleus. After making these various, though not very convincing, assumptions, the author proceeds to discuss the action of nitric acid on chlorobenzene, and of chlorine on nitrobenzene. It is well known that in the first case a mixture of ortho- and para-derivatives results, whereas in the second case a meta-compound is formed. As negative chlorine is present in the nucleus, positive NO_2 will naturally replace positive hydrogen, giving





In the second case, where positive NO_2 is already present in the nucleus, and is acted on by $\overset{-}{\text{Cl}}.\overset{+}{\text{Cl}}$, it is not $\overset{-}{\text{Cl}}$ which is now, as it were, received into the family circle, but his brother, $\overset{+}{\text{Cl}}$, which therefore enters the meta position. One becomes a little bewildered with the sudden *volte-face* exhibited by the differently charged atoms.

The present writer has no wish to do any injustice to Prof. Fry's theory. There is no doubt that it contains a substantial germ of truth; it explains many facts of substitution, and is sufficiently elastic to undergo almost unlimited extension provided all the postulates are accepted.

J. B. C.

Along the Snow-line of Peru.

The Andes of Southern Peru: Geographical Reconnaissance along the Seventy-third Meridian. By Isaiah Bowman. First English edition. Pp. xi+336. (New York: The American Geographical Society of New York; London: Constable and Co., Ltd., 1920.) 27*s.* 6*d.* net.

THIS pleasantly written, highly interesting, and well-illustrated book by the director of the American Geographical Society is one of the results of the Yale Peruvian Expedition of 1911. Its theme was a reconnaissance of the Andes along the 73rd meridian. The author was responsible for the making of a contour map. The north-to-south journey from the 12th to the 17th degree of south latitude cuts the Andes obliquely across from the tropical rubber-producing plains of the lower Urubamba, north-west of Cuzco, southwards over snow-covered passes to the desert coast of Camaná. For weeks the party laboured across and along bleak, lava-covered country, without interruption, at the uncongenial elevation of between 14,000 and 18,000 ft.

The second part of the present volume deals with the physiography of the Western and Eastern Andes, the coastal terraces, geologic development, and glacial features, with many maps and profiles. Other chapters—*e.g.*, those on climatology and meteorological records—are also necessarily severely technical, but the first part of the book is eminently readable, and instructive from a broad point of view. It is entitled "Human Geography," and the author endeavours to show the effect of environment upon mankind in the widest sense. Witness the chapter entitled "The Geographic Basis of Revolutions and of Human Character in the Peruvian Andes." Many of the points raised may appear obvious, others somewhat far-fetched or laboured, and yet they cause us to ponder, and in not a few instances the author makes good his claim by tracing cultural, political, and other conditions to their respective sources—very obvious when pointed out, but requiring a broad mind, open eyes, and travelled experience.

"It is pleasant to think that the tropical forest may be conquered. It is nonsense to say that man now conquers it in any comprehensive and permanent way. The tropics must be won by the strong hands of the lowlier classes which are ignorant and careless of hygiene. We cannot surround every labourer's cottage with expensive screens, oiled ditches, and well-kept lawns. . . . Travel in the desert is a conflict between heat and aridity, but travel in the tropical forest is a struggle against spaces, heat, and a superabundance of all but useless vegetation."

The regional diagrams introduced are most instructive—*e.g.* Fig. 25:

"When amplified by photographs of real conditions, such a diagram becomes a sort of generalised picture of a large group of geographical facts. . . . It would be a real service to geography to draw up a set of, say, a dozen regional generalised diagrams for a whole continent."

The expedition came across the loftiest habitation in the world. It was crossing at 17,400 ft., and 300 ft. lower was the last outpost of the Indian shepherds, built of stone and thatched, sheltering a family of five, with three fat, rosy-cheeked children. Less than 100 ft. below were other huts, and flocks of alpaca and sheep.

The snow-line is here at the surprisingly high level of between 17,200 and 17,600 ft. Potatoes, small and bitter, but edible, and a variety of maize grow up to 17,400 ft., where they endure repeated frosts. "Perhaps the Indians have arrived at results ahead of those by our professional experimenters."

Our Bookshelf.

The Journal of the Institute of Metals. Vol. 25. No. 1. 1921. Edited by G. Shaw Scott. Pp. xiv+522+27 plates. (London: The Institute of Metals, 1921.) 31*s.* 6*d.* net.

THE papers read before the spring meeting of the Institute and contained in the present volume include two contributions of outstanding importance. One of these, by Mr. Moore and his colleagues, describes observations on the season cracking of brass and other copper alloys. The authors have had an opportunity of dealing with an exceptionally large mass of material, and have come to the conclusion that chemical corrosion plays a prominent part in the initiation of season cracking. Their theoretical explanation assumes the existence of an amorphous film between the crystals.

The second paper is by Prof. Carpenter and Miss Elam, and describes the process of recrystallisation of sheet aluminium on annealing, carrying much further the previous observations of the same authors. They have been able to show that the confused structures which have been described as characteristic of cold-worked aluminium are the result of imperfect polishing and etching, and that well-defined structures may be obtained even in severely strained metal. Dr. Haughton has continued his study of the copper-tin alloys and has defined the limits of the solid solutions at the tin end of the series, obtaining, however, some curious results in the variation of the electrical resistance with temperature.

Prof. Edwards and Mr. Herbert describe experiments on the plastic behaviour of heated copper alloys, employing an impact indentation test. Messrs. Moore and Beckinsale have re-investigated the action of reducing gases on copper. Mr. P. H. Brace gives a general account of the metallurgy of calcium, about which little is to be found in the literature. The abstracts of metallurgical papers are very numerous and full, so that the volume constitutes an indispensable work of reference on all matters concerning the non-ferrous metals. Mention should be made of the excellence of the illustrations.

C. H. D.

Freshwater Fishes and How to Identify Them. By Dr. S. C. Johnson and W. B. Johnson. Pp. 64. (London: The Epworth Press: J. Alfred Sharp, n.d.) 1*s.* 9*d.* net.

A BOOK that is both cheap and easy to carry in the coat pocket has long been wanted by those who wish to identify our freshwater fishes. This little volume meets their needs. The descriptions are clear and accurate, and are concerned only with external features, while the majority of the illustrations are in themselves sufficient for identification without reference to the letterpress. The authors' style is not always above reproach; nor do we fathom the meaning of "The sturgeon is considered to be a link between true fishes and sharks, as it has gills as fishes have, and a breathing spiracle, as sharks have." Is it that the authors do not regard sharks as "true fishes"; and if not, why not? The usefulness of all books of this type depends largely upon the ease and speed with which the unknown catch can be run to earth and identified; and we have yet to learn that there is anything better for this purpose than a dichotomous "key." We miss any such key in these pages, and would therefore urge the authors to endeavour in any subsequent edition to introduce a "key" which can be applied rapidly in the field. It would also improve the book if dimensions were consistently introduced into the description of each species: we are told that the gudgeon is usually 5 or 6 in. long when full grown; the "record" chub, however, weighed 7 lb. 4 oz., but no hint of length is given; of the barbel we are given neither the weight nor the length—and so on all through. Nevertheless the book will be welcome to many, and may easily be made so to more.

O. H. L.

Agricultural Economics. By Prof. J. E. Boyle. (Lippincott's College Texts: Agriculture.) Pp. ix+448. (Philadelphia, London, Chicago: J. B. Lippincott Co., 1921.) 12*s.* 6*d.* net.

PROF. BOYLE'S book covers a wide field and deals with a subject of increasing importance. It has long been a commonplace that agriculture is a business as well as a science, but only recently have the business principles been clearly enunciated and developed. The book is a useful contribution; the author's position as professor of rural economy at Cornell University brings him in contact with the realities of the subject and saves the work from the danger of becoming commonplace. The author has a good deal to say about the chaos that sometimes seems to reign supreme in agriculture, but we are not sure that it really is as bad as it appears; prior to the war the world's supply was on the whole approximately equal to the demand, and no great "carry-over" was necessary, nor was there a marked deficit. He is on safe ground, however, in insisting on the need for the full co-ordination of production and consumption, and his discussion of the factors concerned in successful business management is both interesting and suggestive.

The Child's Path to Freedom. By Norman MacMunn. A second edition, entirely re-written, of *A Path to Freedom in the School,* dealing with six further years of educational experiment. Pp. 163. (London: G. Bell and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THIS stimulating and original book deserves to be studied carefully by every educator, for it illustrates well the value of the application of modern psychology to the problems of mental development. There is much in it which will be actively criticised, but it is well to have educational orthodoxy challenged to defend itself or to modify its procedure, as is done in the pages of this little volume.

Letters to the Editor.

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

Uniform Motion in the Æther.

I SHOULD like to say a few words relative to Dr. Jeffreys's comments on my letter on the above subject in NATURE of August 11, p. 746.

Poincaré asserted that optical phenomena were, in his opinion, rigorously independent of any motion other than the relative motion of the bodies concerned, and this is, I believe, a cardinal tenet of relativity. In my judgment, the case of the moving mirror shows such rigorous independence to be logically impossible, but I do not quite gather whether Dr. Jeffreys accepts or rejects that point of view.

Allowing for the FitzGerald contraction, and also for the aberration, there will be, for an observer on the earth, a general apparent equality of the angles in question only when the motion of the earth is in the plane of the mirror. (I was guilty of a slip here, but so, I think, was Dr. Jeffreys, since, even disregarding the aberration, a motion of the earth normal to the mirror could scarcely allow of the same standard of angular equality for both earth and mirror, the motion of the latter in this case not being normal to its own plane.) Clearly, the existence of such equality determined by and determining one specific direction, is an optical phenomenon which depends on the absolute motion of the earth, not merely on the relative motions of earth and mirror; and if this be admitted it appears to me that the whole structure of relativity falls to the ground, in so far at least as it may not be able to dispense with logic.

As to other points, I believe that if Dr. Jeffreys will consider more closely the manner in which a distortion of the apparatus by the FitzGerald contraction would introduce discrepancies into stellar measurements, he will see that these discrepancies, if discriminable, would reveal, not the relative motion of stars and earth, but the absolute motion of the latter; and a comparison of this with the ordinary estimation of the earth's motion relative to the stars would show whether the whole material universe had a drift in space. Again, I do not find it possible to agree with Dr. Jeffreys that the Michelson-Morley experiment conducted through water would be of little interest. Indeed, it seems to me that this might constitute a crucial test of the whole theory. Supposing Fizeau's law for the light velocity in moving water to be of general application, I believe I am correct in saying that the change of length that must be suffered by the apparatus in the direction of the earth's motion, if the result of the experiment in water moving with the earth is to be negative, should be in the proportion

$$1 : 1 - \tfrac{1}{2}\frac{u^2v^2}{c^4}$$

instead of

$$1 : 1 - \tfrac{1}{2}\frac{u^2}{c^2},$$

as in the FitzGerald contraction, v being the velocity of light in water at rest in the æther and u being small. This would represent only about one-half of the latter contraction, and the test should therefore be decisive under the suppositions made. It is true that I have not allowed for the effect of the FitzGerald contraction upon Fizeau's law, but I do not know that there is general agreement as to the method of estimating this effect, and it seems very improbable that the result would be a complete elimination of v from the expression giving the contraction.

E. H. SYNGE.

Dublin, August 15.

IF we refer several events to the same system of position and time co-ordinates, and then consider the same events referred to another system, the position co-ordinates and times in the two systems are connected by a set of algebraic relations, called the Lorentz-Einstein transformation. The FitzGerald contraction refers only to a part of these relations between the co-ordinates; an argument that assumes it and omits to consider the other relations is not dealing with the principle of relativity. If the positions and times in two systems of reference B and C are connected with those in another system A by such transformations, those in system C can be found in terms of those referred to B by algebra, and it is found that the relation between B and C is another Lorentz-Einstein transformation, and involves no mention of A whatever.

In Mr. Synge's problem of the mirror, we may call the "æther" system A, the earth system B, and the mirror system C. Even if there was a fundamental æther, his suggested experiment deals only with the relations between B and C, and, in consequence of the above theorem, can therefore be treated in terms of their relative motion alone. The "absolute" motion never enters into the question. It would enter, of course, if we tried to tackle the problem by referring everything to system A, but it would be found that the absolute motion eliminated itself when the angles of incidence and refraction were compared. Aberration does not affect the problem, for it increases or reduces both angles equally.

I see no reason to alter anything in my previous note. It is perfectly true that the theory of relativity makes certain positive predictions, and would have to be modified seriously if any of these were proved false by experiment. But it is not true that it predicts anything that involves the absolute motion of the earth in space. Nothing but experiment could refute it; its self-consistency is perfect.

HAROLD JEFFREYS.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

IN a series of papers from 1916 onwards Wherry has studied the relation between soil reaction and plant distribution in the United States. He made use of colour tests with indicators for determining the hydrogen-ion concentration of the solution obtained by agitating soil taken near the plant with water. In this manner he showed that the distribution of a species may be limited in a very definite way by the soil reaction, in expressing which it is convenient to record the results in terms of the logarithm of the reciprocal of the hydrogen-ion concentration in grams per litre. This is denoted by the symbol pH, neutrality is at pH7, centi-normal hydrochloric acid is at pH2, and sea-water at about pH8.

Wherry has given the limits for a number of American plants, and shown the soil reaction to be expected in various types of soil. A paper dealing with the subject has also appeared recently in Sweden, giving results obtained by O. Arrhenius, but this is not accessible here as yet.

During the last year determinations of the pH values of soils have been carried out by the writer in India and the British Isles with the view of extending our knowledge of plant distribution. It has been found that Java indigo can tolerate wide changes in reaction, growing in Bihar in soil at *p*H8·7 and in Assam at *p*H5·4. It, however, does much better in the latter for various reasons.

In the British Isles it has been found that the yellow stonecrop, *Sedum acre,* flourishes in soil from *p*H7 to 8 or over, whereas the white *S. anglicum* may be growing at from *p*H6·8 to 5·1, possibly slightly outside these limits. Plants which are by some regarded as typical species of limestone districts may be found elsewhere provided the soil reaction is suitable; thus *Salvia verbenaca* grows between *p*H7 and 8, *Crithmum maritimum* around *p*H8, and *Cochlearia danica* from *p*H7·5 to 8, possibly over it, much the same range being occupied by *Linaria cymbalaria*; for *Centranthus ruber* values from *p*H7·4 to 8·8 have been obtained. The common gorse, *Ulex europaeus* is usually found on acid soil; in seven cases where it was observed growing in abundance the reaction was *p*H6·8 to 5·4, but one plant was found at *p*H8·1, one at 8·2, and three or four at 8·6. In other cases the soil was probably alkaline, but was not tested.

The sea pink, *Armeria maritima,* may be found between *p*H6·8 and 8·2, but the typical sand-dune plants, *Ammophila arenaria, Euphorbia Paralias, Salsola Kali,* are found only in the neighbourhood of *p*H8.

Moorland plants, *Erica tetralix, Anagallis tenella, Drosera rotundifolia, Jasione montana,* etc., are commonly found at *p*H5·5 to 5, or thereabout, but the limits are certainly wider.

The accumulation of data of this type is of necessity a slow process, but one cannot fail to be impressed by the fact that the presence or absence of a plant in a given locality stands in close relation to the hydrogen-ion concentration of the soil. Plants may survive, or even do well, in cultivation outside their normal limits, but in free competition with their neighbours the soil reaction is often the deciding factor—always, in fact, if the divergence from the normal *p*H value for the species is sufficiently great.

Considerable changes in the soil reaction may be met with in quite a short distance. Thus on crossing a road at Youghal, Co. Cork, one passes from a soil of about *p*H7·5, with *Salvia verbenaca* and *Ononis arvensis,* to an acid soil, *p*H6·8 to 6·4, with gorse, and in the wet parts *Iris pseudacorus* and bog-cotton. This, in turn, passes into sandy pasture and sand dune, the latter giving about *p*H8. Again, near Cawsand, in Cornwall, gorse is plentiful on the felsite soil at *p*H6·4 to 5·4, but absent from the adjacent, and similarly situated, soil of the Staddon Grits, which normally gives *p*H7 to 7·8.

It appears as if corresponding differences are shown by water-plants and fresh-water algæ, the upland waters which are very slightly acid or almost neutral favouring the desmids. There is much room for further work along these lines.

W. R. G. Atkins.

August 30.

"Smoky" Quartz.

The deeply tinted varieties of quartz, such as "smoky" quartz and the yellow or Madagascar variety, are generally transparent in the infra-red region of the spectrum to the same extent as clear rock-crystal, as may easily be demonstrated with the aid of a thermopile and galvanometer. I wish to suggest that a very simple physical explanation of this property may be offered. As has been emphasised in a paper by Prof. R. J. Strutt (now Lord Rayleigh) in the Proceedings of the Royal Society for 1919, these varieties of quartz are really optically turbid media, the opacity arising from the scattering of the radiations in their passage through the crystal by a cloud of small particles present as inclusions. Since scattering of this kind is effective in inverse proportion to the fourth power of the wave-length, it can easily be seen why the longer heat-waves can traverse the crystal without appreciable loss. Some photometric observations which I have made of the relative transparency of the yellow and colourless varieties in different parts of the spectrum support this explanation.

In the paper just quoted Rayleigh has described the very beautiful and striking effects that arise owing to optical rotatory dispersion when a strong beam of *polarised* light is sent through a block of smoky or yellow quartz in the direction of the optic axis; the track of the beam, as made visible by the scattering particles and observed in a transverse direction, shows bright and dark bands if monochromatic light be used, and alternations of colour if the incident beam is of white light, the effect being due to the fact that the scattering particles themselves act as *analysers* of the light incident on them. I find that the phenomenon discovered by Lord Rayleigh can be very prettily shown in another way which is also instructive. A thin, flat sheet of *unpolarised* white light may be sent through the crystal in a direction *transverse* to the optic axis, and the track of the beam observed in a direction parallel to the optic axis through a Nicol. In this case the scattering particles act as *polarisers*, and the scattered light suffers a rotatory dispersion of its plane of polarisation in traversing the quartz along the optic axis before reaching the observer's eye. Hence the whole track of the beam as seen through the observing Nicol appears coloured, the tint fluctuating periodically with the thickness traversed as the block is moved to and fro in the line of sight or when the analysing Nicol is rotated.

Rayleigh has shown in his paper that the track of a beam of light traversing a beam of *transparent* colourless quartz can be successfully photographed. I find that by using a concentrated beam of sunlight it is possible *visually* to detect the Tyndall blue cone even in this case. Its intensity, however, is exceedingly small.

C. V. Raman.

22 Oxford Road, Putney, S.W.15,
September 4.

Brown Bast and the Rubber Plant.

In Nature of June 16 (p. 499), in a paragraph which announces the discovery by the Botany Department of the Imperial College of Science and Technology that "'brown bast' (the most serious disease of *Hevea brasiliensis*) is essentially a question of phloem necrosis," it is stated that Sanderson and Sutcliffe have shown that "burrs result from the inclusion of areas of diseased laticiferous tissue in stone-cell 'pockets' formed by the activities of wound cambiums."

It should be pointed out that the presence of latex vessels in the core of nodules (burrs) was first recorded by Bateson (Agric. Bulletin Fed. Malay States, August, 1913, p. 24), and later corroborated by Richards and Sutcliffe ("*Hevea brasiliensis*," 1914, Malay Peninsula Agric. Assoc.), and by myself (Bulletin 28, Dept. of Agric., Ceylon, October, 1916, and Annals Roy. Bot. Gdn., Peradeniya, vol. 6, p. 257, 1917).

Workers in Java have further confirmed this inclusion of laticiferous tissue as regards the nodules which follow brown bast, and the fact that nodules in the most general case result from the inclusion of areas of diseased laticiferous tissue has been common knowledge in the East for the last five years. That the formation of nodules after brown bast is a secondary symptom has also been generally recognised. Nodule-formation, however, occurs in many cases other than those in which it is merely a secondary symptom of brown bast.

The occurrence of diseased sieve-tubes in brown bast tissue, prior to the appearance of the disease in or adjacent to the latex vessels, has not been previously recorded, and if this is corroborated it may lead to further advance in our knowledge of this disease.

The statement that the diseased laticiferous tissue is enclosed in "stone-cell pockets" formed by the activities of wound cambiums is at variance with the results obtained by workers in the East generally. Occasionally stone-cell groups, which are abundant in normal cortex, are fortuitously enclosed within the nodule cambium at the time of its inception. The nodule cambium by its subsequent division lays down wood elements on the inside and cortical elements on the outside. It is a striking characteristic of cortex overlying old nodules, and presumably entirely derived from the nodule cambium, that stone-cells are completely absent.

G. BRYCE,
Asst. Botanist and Mycologist.
Department of Agriculture, Peradeniya, Ceylon,
July 21.

MR. BRYCE is quite correct in his reference to the work of Bateson and others. In a brief note, however, historical reference to the bibliography of "brown bast" and related phenomena was not contemplated for a moment. The work of Sanderson and Sutcliffe was mentioned in consequence of the recent publication of their book on "Brown Bast." With the Editor's permission, it is proposed to deal further with the subject of this disease in a future issue of NATURE.

THE WRITER OF THE NOTE.

The Nature of Vowel Sounds.

IF you will permit me to refer at this late date to Prof. Scripture's articles in NATURE of January 13 and 20 last on the nature of vowel sounds, I should like to emphasise the great service that the writer has done in pointing out that the ordinary methods of harmonic analysis are not necessarily adequate for the determination of the composition of a given tone, and may, indeed, give quite a false representation of the facts, because the sound may have inharmonic components. At the same time, it is doubtful whether his note in NATURE of March 3 (p. 12) in reply to another correspondent, interpreting some of Prof. Miller's results in this field, are justifiable. Prof. Miller's curves are evidently harmonic, from the fact that they repeat themselves very faithfully at regular intervals and establish without much doubt that vowel sounds (and some others) at least *can be* so produced that they are susceptible of harmonic analysis, whether they are always of such nature or not. The fact that Prof. Scripture finds the quality of the voice constantly changing in speech is not a matter of surprise, any more than that the human face and form rarely remain exactly the same for two seconds at a time in waking hours; it need not preclude us, however, from seeking to maintain a given quality for a time for purposes of analysis and record, any more than the latter fact prevents us from sitting for portraits.

There is, however, a point in the first article that is open to distinct criticism. The author says (p. 633):—"In the analyses of vowel waves the fundamental is indicated as weak, or often almost lacking. . . . We all know that this is the strongest tone of all." It takes all the point out of scientific research if we are going to discard its plain results for what "we all know," especially if the fact of "knowledge" stands on such weak grounds as does the one here referred to. All that we are justified in saying is that a complex note is by common judgment considered as having the pitch of its fundamental; this may happen in cases in which the fundamental is known to be weaker than the upper partial or partials—a fact for which we have the authority of Ohm, Helmholtz, and the late Lord Rayleigh ("Theory of Sound," vol. 1, sec. 26). When Prof. Scripture states that fundamentals are "not of the nature of sine vibrations," he deprives us of any rational definition of the term; we could build up his type of fundamental vibration from a number of sine vibrations of shorter period, and thus produce a sound of low pitch from a number of high-pitched ones.

What I believe to be the true interpretation of Prof. Scripture's results and those of others in this field—in fact, the inescapable conclusion—is that the fundamental is, indeed, extremely weak in many of the tones produced by the voice and other musical instruments, and that it is further masked in the records by the comparative lack of sensitiveness of the ordinary recording apparatus in the lower ranges. We must then also conclude that there is something in the physiology or psychology of hearing, or in both combined, whereby the lowest component of a complex tone, the fundamental, fixes for the hearer the pitch of the whole tone, while the presence or absence of certain upper partials and their relative strength determines its quality.

The glottal puff theory is not inconsistent with the harmonic theory. Helmholtz accepted it and stated it very clearly, as seen in the following extract from his "Tonempfindungen" (Ellis's translation, p. 103):—"In order to understand the composition of vowel tones we must, in the first place, bear in mind that the source of their sound lies in the vocal chords, and that when the voice is heard these chords act as membranous tongues, and, like all tongues, produce a series of decidedly discontinuous and sharply separated pulses of air (*Luftstösse*), which, on being represented as a sum of simple vibrations, must consist of a very large number of them, and hence be received by the ear as a very long series of partials belonging to a compound musical tone." There remains to be applied a positive test, which, as Prof. Scripture points out, should not be dependent on the harmonic analysis of curves to determine whether or not Helmholtz was right in concluding that the partials of the voice tones are harmonic.

With reference to another point in the articles, it seems to me to be no more justifiable to say that the difference between the voice of a Caruso and that of a costermonger lies solely in the vocal chords than it would be to say that the tone of a reed instrument depends only on the reed, without reference to the size, shape, material, etc., of the rest of the instrument, *e.g.* that the difference between a bassoon and an oboe is only a difference of reeds.

PRESTON EDWARDS.
Clark University, Worcester, Mass., July 11.

THE first essential point of the interesting communication of Mr. Preston Edwards lies in the question of the weakness of the fundamental in the tone of a vowel. This tone is that of the larynx, or the voice tone. To the ear this is always the predominating tone. We may not be able to distinguish what vowel a singer is producing, but if we can hear him at all we hear the tone he is singing—that is, the tone from his larynx. When a larynx from a freshly killed animal is subjected to a blast of air and the vocal chords are brought together, a strong tone is produced.

Mr. Preston Edwards makes the hypothesis that a weak larynx tone arouses a complex of resonance tones in the vocal cavities, and that these are then heard with a strong lower tone corresponding to the larynx tone. We can sing all the vowels with a single strong larynx tone; that all the varied resonance tones should coincide in producing this single strong larynx tone is quite beyond imagination. It is scarcely necessary to follow this thought out; the fact remains that the larynx tone is by far the strongest tone in the vowel, both physically and for the ear.

A comparison of vowels with tones from reed instruments is inadmissible. The resonating cavities in the latter have hard walls and can force their periods on the reeds, whereas the vocal cavities have soft walls and cannot do so.

Helmholtz's theory of the vowels rests on three assumptions:—(1) The vibrations from the larynx are of the form of a simple sinusoid or of the sum of a harmonic series of simple sinusoids. (2) The vocal cavities act like resonators with hard walls. (3) The larynx tone is maintained at constant pitch. This is the condition exemplified in Helmholtz's vowel apparatus, in which tuning-forks (representing the larynx tone) are maintained electrically in vibration before brass resonators (representing the vocal cavities). Such resonators can respond only to harmonics of the fork tone. If the three suppositions are true, the harmonic theory necessarily follows.

In an interesting apparatus devised by Dr. H. Hartridge a series of weights is hung by threads of different lengths from a bar that can be set in sinusoid vibration. When the bar is started all the pendulums begin to swing, but after a few vibrations all become still except the one that corresponds to a harmonic of the period of the bar. It takes, therefore, several vibrations before the period of the bar is forced on the appropriate pendulum, and the others are forced to become still. Remembering the first fact—that a single movement of the bar starts all the pendulums—let us now drop the third supposition above and conform to the truth that the voice tone is never of a constant pitch for a single instant. In speech it changes so rapidly up and down that two successive vibrations are rarely of the same pitch. Each single vibration must start all the pendulums—that is, all the tones of the resonators—and there is no possibility that the tone of the voice can force itself on the resonators. Even retaining the first two suppositions, we are forced to conclude that any harmonic adjustment of the vocal resonators to the voice tone is impossible, because it takes at least two like periods of the voice tone to force its frequency on a resonator, whereas in actual speech the voice tone does not have two like periods in succession. The Helmholtz theory is thus impossible, because the third supposition is contrary to fact.

Let us now examine the effect of retaining the first and third suppositions while modifying the second to fit the facts. The resonators have soft walls, and any vibration aroused in them will die away rapidly. Even if the laryngeal vibration were of the sinusoid form, the resonance vibration aroused by one positive (or negative) phase would die away before the corresponding phase occurs again. To a simple sinusoid or a tuning-fork tone there is at the best only a weak response. With more complicated sinusoids or sharper tones there may be rapidly repeated overtones that evoke some response. The result is utterly different from the loud responses evoked by forks held in front of resonators with hard walls.

The moment we give up the first assumption and accept the fact that the tone from the larynx consists of a series of sharp blows, and not of continuous vibrations, all possibility of the harmonic hypothesis vanishes. A sharp blow can arouse only the free vibration of the cavity, whether hard or soft. The tones aroused are those of the cavities themselves. Their periods have no relation to the period of the blow, simply because the blow itself has no period. Even in a cavity with hard walls the aroused vibration dies away so quickly that the blow would have to be repeated rapidly in order to catch any of the dying motion.

As explained in my account in Nature (January 13 and 20, pp. 632 and 664), every one of the three assumptions is contrary to fact. If Helmholtz had had the data we possess to-day the Helmholtz theory of the vowels would assert that the cavity tones may bear any relation to the larynx tone. The whole thing follows so easily and naturally from the facts that he would have drawn the unavoidable conclusion, and not have become involved in the difficulties and impossibilities caused by asserting that this relation must be harmonic.

Of course, this has nothing to do with the Fourier analysis. This method gives us a plot of what harmonics might be used to reconstruct a curve. The profile of a face can be resolved into a series of harmonics. The blunder occurs when someone supposes that this mathematical analysis proves anything physical. The analysis of the profile does not prove that the face was constituted of harmonics. As explained in my first article, the harmonic plot of a vowel wave represents a mathematical formula. As soon as we attempt to give a physical interpretation to this formula we are forced to reject the harmonic theory and to assert that the vowel tones may bear any relation whatever to the fundamental. The Fourier analysis still remains the only way of analysing vowel curves, and its results prove the independent theory of the vowel tones. E. W. Scripture.

The Generation of Heath-fires.

Is Mr. Martin (Nature, August 25, p. 811) certain that the fire seen by him had not spread through the peat from a neighbouring area recently ablaze? That such subterranean combustion may persist for many days and spread a long distance is common knowledge.

Experience shows that the surest way of preventing fires is to cut away the heather; whereas, on Mr. Martin's hypothesis, by exposing the loose soil to the direct rays of the sun this procedure should add a new risk. Henry Bury.

Mayfield House, Farnham, Surrey, August 26.

Life and Mind.

During the past six months Nature has published many articles and reviews about life and mind, but there has been no clear and precise definition of these two terms; so permit me to submit for the serious consideration of your scientific readers a brief statement of what appears to be the true position of affairs:—

(1) We depend only upon evidence of what is called "matter" and its various *states*.

(2) Life is a state of certain kinds of matter when physical conditions are favourable.

(3) Mind is the state of some portion of a living organism—in man the cerebral cortex, where thousands of nerve-endings are concentrated.

This is no attempt to explain the *how* and *why*; but can the facts, if facts they be, be expressed more simply or concisely and with greater precision? The question may appear trivial, but it has an important bearing on other subjects which are alluded to from time to time in Nature. Sesamy.

The Stream of Life.[1]

By PROF. ARTHUR DENDY, F.R.S.

ALL typical organisms—animal or vegetable—are composed of cells; minute nucleated masses of protoplasm, existing either singly or in many-celled aggregates. These cells are capable of reproducing themselves by a process of division, and each of the higher organisms, with certain negligible exceptions, starts its life in the condition of a single cell which we call an egg or ovum, or, to use a more general term, a germ-cell.

Whatever may have happened in the far-distant past, at the present day, so far as we can see, every living thing is the product of some pre-existing living thing, the relation of parent and child holds good throughout the whole organic world, and when we come to analyse this relationship from the biological point of view we find that it is always essentially based upon cell-division. Leaving out of account, as we may legitimately do for our present purposes, the stages of protoplasmic evolution that precede the appearance of the nucleated cell, we may say that the cell is the unit of organic structure, that all organisms are built up of such units in somewhat the same way as a house is built up of bricks, except that the process of building in the living organism is one of cell-growth and cell-multiplication, while the bricks of a house are brought together and combined into a building by some external agency. This fundamental conception of organic growth leads to the still more fundamental conception of living matter as a continuous stream of protoplasm, starting with the first appearance of life on the earth and continuing to the present day with undiminished vigour; but it is a stream which in the process of time constantly branches out in new directions, giving rise ever to more complex and more diversified types of plants and animals. It is the stream of life. To make use of a more familiar metaphor, the whole organic world may be compared to a great tree, the roots of which are dead and buried in the past, and the leaves and flowers of which, individualised and endlessly diversified, are represented by the living plants and animals of to-day.

Let us now examine a little more closely the means by which successive generations of organisms, parents and offspring, are linked together. We have to ask ourselves the question: Why do all except the simplest organisms reproduce themselves by means of eggs, instead of simply dividing up into equivalent parts? In other words, why does every plant and animal of a new generation have to go back to the beginning and start its life as a single cell? We may approach this question by considering for a moment a once familiar domestic operation—the baking of bread. You have no doubt sometimes heard the expression "half-baked" applied to human beings, which shows that the analogy I propose to make use of is not altogether new. If we want to increase the number of our loaves it is no good simply cutting them in halves. We must go back to the dough and out of it fashion new loaves. The dough, properly prepared, contains all the ingredients necessary for bread-making and is capable of developing into loaves when subjected to the right treatment. When once it has developed into a loaf, however, it cannot be turned back again into dough.

So it is also with the living organism. When once the protoplasm of the egg, or germ-plasm, as it is technically termed, has developed into the mature tissues and organs of the adult body, it cannot, usually at any rate, be turned back again into germ-plasm; it continues to live for a time, but the stress and strain of life gradually exhaust its vitality; for a time, tissues and organs may be renewed, but ultimately some essential part of the mechanism of the body is worn out beyond the possibility of repair, and the death of the entire organism inevitably follows.

What provision, then, is made for the next generation—who mixes the next batch of dough? Here I am afraid our analogy breaks down, and it breaks down just because the germ-plasm, unlike the dough, is a living substance capable of increasing itself indefinitely by growth and multiplication. What happens is typically this—a part of the original germ-plasm of each generation is set aside, taking no share in the development of the body, but remaining in the condition of comparatively undifferentiated protoplasm, while continuing to increase and subdivide into germ-cells. It thus appears that the old idea that the hen produces the egg is scarcely correct—it seems that the egg produces the hen and at the same time more eggs, which are accidentally, as it were, included in the body of the hen. The constant succession of germ-cells, each produced by division of a parent cell, constitutes the only really continuous stream of living protoplasm. The bodies of individual plants and animals, developing from the germ-cells, may be compared to local and temporary overflows from the stream, which sooner or later dry up and disappear, or, in other words, die. This is Weismann's well-known doctrine of the "continuity of the germ-plasm," and for our present purposes we may take it as substantially correct, in principle if not in detail.

The simpler living organisms, which, like the amœba, consist each of only a single cell, are exempt from death, because in them the stream of protoplasm forms no overflows; it consists entirely of germ-plasm, and no differentiated bodies are formed, so that there is nothing to die, nothing which cannot go on reproducing itself indefinitely. Death is the penalty paid for a higher

[1] From a citizens' lecture delivered at Edinburgh on September 8 during the meeting of the British Association.

life, based upon a greater complexity of bodily mechanism.

In all that has been said hitherto, which must be already very familiar to most of you, we have been endeavouring to pave the way for the consideration of what is perhaps the most difficult and certainly the most vigorously discussed problem of biology—the problem of heredity. With regard to single-celled organisms such as the amœba, this problem scarcely exists. Division of the parent cell entails division of all that that cell possesses. The daughter-cells resemble the mother simply because they are that mother divided into two equal and similar parts.

With the higher organisms, each composed, perhaps, of many millions of cells, differentiated into many different kinds, and building up the most diverse tissues and organs, the situation is very different. In such a case how can a single, apparently undifferentiated, germ-cell, which has never taken part in the formation or in the activities of the body as a whole, and exhibits none of the features which characterise the tissue-cells—how can such a simple cell give rise by growth and multiplication to all the different kinds of cells, arranged in all the different tissues and organs, more or less exactly as in the parent?

The development of such an infinitely complex organism as, for example, the human body, from a microscopic egg-cell of apparently simple structure, seems, indeed, a kind of miracle, and the more closely we compare parent and child the more miraculous does the result appear, for not only is there a general resemblance in all essential features, but there is very frequently also a particular resemblance in minute peculiarities, such as the colour of the hair or eyes, the contour of the features, and so on.

It would be claiming far too much to say that we have as yet arrived at any complete explanation of heredity—this marvellously accurate reproduction in the child of the most minute details of bodily and mental organisation exhibited by the parent. But the explanation is, perhaps, after all, not quite so difficult as it seems at first sight. Let us go back to our loaves of bread and ask ourselves why one loaf resembles another. Why does the loaf that is baked on Tuesday resemble that which was baked in the same oven on Monday? The answer is obvious. One loaf resembles another because it is made from the same kind of dough and subjected to the same kind of treatment. If you take a different kind of dough, or subject the same dough to a different treatment, you will get a different result—and, as every housewife knows, there may be a vast difference between the loaves turned out by different bakers. The characters of the loaf clearly depend upon two sets of conditions: first, the nature of the dough itself, whether, for example, it is mixed with yeast or baking powder, water or milk, salt or sugar, and so on; and, secondly, the nature of the treatment to which the dough is subjected, the shape of the tins in which it is baked, the temperature of the oven, and so forth. If all the conditions are accurately repeated for successive batches of loaves, then the loaves of each batch will resemble those of the preceding batch.

We have in this respect a very close analogy with what takes place in heredity. The egg consists of a certain quantity of germ-plasm, and this germ-plasm has certain characteristic peculiarities of its own. In order that it may develop into an adult organism like the parent, it must be subjected to a certain treatment. In the case of a hen's egg undergoing incubation, or of the human fœtus developing in the womb of the mother, we may truthfully say that it has to be baked in an oven at a particular temperature. Only if all the conditions are accurately fulfilled will the egg develop into an organism resembling the parent, and it does so simply because the same causes must always produce the same effects. If you start with identical germ-plasm and expose it to identical conditions during its development, you must get an identical result. The child must resemble the parent. It is, indeed, easy to show by experiment that if you vary the conditions you may get either no result at all or a different one. Up to a certain point, however, the living organism has the power of counteracting accidental influences, and thereby maintaining its normality of structure. In other words, it is self-regulating, and seems to be always endeavouring to carry out the plan of structure characteristic of the species to which it belongs, so that, if this plan be disturbed, it will, within limits, be restored again by appropriate growth and readjustment. This power of adhering to a predetermined structural plan, in spite of disturbing influences, is one of the most distinctive attributes of living beings, and must on no account be lost sight of in considering the problem of heredity; but at the same time it is a power that is strictly limited.

A well-known American investigator, Prof. Stockard, has recently shown, in the case of various animals, how abnormalities can be produced by simply lowering the temperature during development. Some years ago the same observer obtained even more surprising results by the use of a simple chemical reagent. He exposed the eggs of the American sea-minnow (Fundulus) to the action of magnesium chloride, and found that the young fish tended to develop with a single eye in the middle of the head, instead of one on each side, though the modification was not in all cases complete. Thus we see that it is possible, by the application of a specific chemical stimulus to the egg, to bring about a profound and perfectly definite change in the structure of the organism, though we are still far from knowing why this should be the case.

We also know, from recent physiological research, that the growth of various organs in the animal body is normally controlled by infinitesimal quantities of chemical substances secreted by the ductless glands, such as the thyroid and the pituitary, and circulated in the blood, and that any deficiency or excess of these substances may produce abnormal results. The discovery of these hormones, as they have been termed by Prof. Starling, must have a profound influence on our ideas as to the mechanism of heredity. Their significance from this point of view was, I believe, first pointed out by Mr. J. T. Cunningham many years ago. It seems at least possible that chemical substances of a like nature may exist in the germ-cells and exercise a profound influence upon their development.

With this possibility in view, let us again examine the egg-cell at the very commencement of its development into a multicellular body, at the moment of its division into the first two daughter-cells, and let us concentrate our attention upon the nucleus, which always divides first. As it prepares itself for this important event a number of peculiar bodies called the chromosomes make their appearance, apparently by concentration of previously scattered granules of chromatin substance, so-called because of the way in which it can be stained by certain dyes. At the same time, a spindle-shaped arrangement of threads becomes manifest and the nuclear membrane disappears, so that there is no longer any sharp division between nucleus and cell-body. The chromosomes, often varying in shape and size amongst themselves, but definite and constant for each kind of organism, arrange themselves across the middle of the spindle. Then each splits into two, and one half moves away from the other and towards the corresponding end of the spindle. We have now two groups of daughter-chromosomes, and around each group a new nucleus is constituted. Then the protoplasm of the cell-body divides into two parts, and two complete cells are formed, each with its own nucleus.

The process is really far more complicated than this brief and inadequate description might lead you to suppose, but the essential feature seems always to be the behaviour of the chromosomes. It is very evident that the protoplasm of which these are composed must be of the utmost importance to the organism, and that it is necessary that it should be very accurately divided between the daughter-cells every time cell-division takes place. This phenomenon of mitosis, as it is termed, is of almost universal occurrence throughout the animal and vegetable kingdoms, not only in the early divisions of the egg-cell, but throughout the entire life of the organism, whenever cell-division takes place. It is clearly a contrivance by which a certain material substance—a particular kind of living protoplasm—is accurately distributed amongst the progeny of a dividing cell In other words, it is part of the mechanism of inheritance.

Let us now turn aside for a moment and glance very briefly at another and totally different line of evidence, leading to results which confirm and explain in a very remarkable manner those which we have already arrived at. I refer, of course, to the modern experiments in the breeding of plants and animals, undertaken under the influence of what is frequently termed the Mendelian school. It is utterly impossible to do justice to these wonderful experiments in the time at our disposal. I would point out, in the first place, however, that they have led quite independently to the striking conclusion that there must exist in the protoplasm of the germ-cells definite material entities—the so-called Mendelian factors—which are in some way or other responsible for the appearance in the adult organism of special features—the so-called unit characters—capable of being handed on from one generation to another by the process of heredity. Assuming them to be located in the chromosomes, the behaviour of these factors in inheritance, the permutations and combinations of unit characters which arise in cross-breeding, can be adequately explained by the behaviour of the chromosomes actually observed at certain critical periods of the life-cycle.

Take, for example, the colour of the human eye. If a certain factor, or combination of factors, alone be present in the germ-plasm, the eye will be blue or grey, but the addition of another factor may cause it to be brown, and the average results, as regards eye-colour, of mating pure blue-eyed and pure brown-eyed individuals can be confidently predicted. The occasional appearance of an extra thumb or finger upon the hand, which is well known to be a heritable character, transmitted with great regularity from parent to child, is again supposed to be due to the occurrence of a corresponding factor in the germ-plasm, and so on with a whole host of characters that have been carefully investigated by means of breeding experiments in recent years. It is important to note that these characters seem to bear no purposeful relation whatever to the well-being of the organism in which they occur. They are often extremely insignificant, and a large proportion of them must undoubtedly be regarded as abnormalities. It is a mere matter of chance whether they happen to be useful, neutral, or injurious.

We cannot attempt to discuss, or even state, however briefly, the evidence upon which this factorial hypothesis rests. Suffice it to say that it seems to afford the only possible explanation of the results of the long series of experiments inaugurated in Austria by the classical work of Mendel in the middle of the last century, carried on by Bateson, Punnett, Biffen, and others in England, and culminating in the brilliant investigations of the American school of geneticists under the leadership of Morgan.

The investigations of Prof. Morgan and his colleagues have gone so far as to demonstrate conclusively, albeit indirectly, not only that the Mendelian factors must be located in the chromosomes of the nucleus, but also that they must be arranged in each chromosome in a perfectly definite manner. These observers have even prepared maps of chromosomes showing the arrangement of the factors in linear series. It is surely one of the most remarkable achievements of modern science that we should be able to point to a particular spot in a particular chromosome of a microscopic germ-cell and say with confidence that there is something just there that is responsible for some particular character, such as the colour of the eye, in the adult organism.

As to the nature of the factors themselves, it seems not unreasonable to conclude that they must consist of definite chemical substances, or, perhaps better, of chemical modifications of living protoplasm, in the form of minute particles too small to be rendered visible by any means yet discovered, but capable of self-multiplication like other protoplasmic units.

We may further suppose that these factor-forming substances play a part in controlling the development of the organism comparable with that played by magnesium chloride in the case of the developing embryos of the sea-minnow, or by other chemical substances (hormones) in the normal adult animal. The complex mechanism of mitosis in the division of the cell-nucleus would then appear to be necessary in order to secure the proper distribution of factors throughout the growing body, so that each may reach the particular part that it is destined to influence.

It must be remembered that the occurrence of Mendelian phenomena in heredity depends entirely upon a much more fundamental phenomenon —that of sex—which gives the experimenter the opportunity of crossing two individuals differing as to one or more separately heritable characters, and of observing the numerical proportions of the offspring in which each of these characters makes its appearance.

The phenomenon of sex, as we all know, is a very great mystery, and introduces endless complications into life. Sexual differentiation appears to be nearly as old as the cell itself. The stream of life, almost since it first began to flow, has been a double stream, or, better, a network, in which male and female streamlets unite at more or less frequent intervals to form those temporary overflows which we call individuals. Each streamlet goes its own way for a time, and then joins and exchanges experiences, so to speak, with another. It is just this exchange of experiences that forms the basis of the Mendelian phenomena, and it is not merely the experiences of a single lifetime, but those of many generations that may be thus exchanged.

Perhaps, however, we are getting a little too metaphorical and had better consider in a rather more matter-of-fact manner what actually takes place in the sexual process. The essential feature of this process is always the same—the union of two germ-cells to form a single cell, although this fundamental act is greatly obscured in the higher plants and animals by the endless contrivances which have arisen in the course of evolution, and which serve the ultimate purpose of bringing the germ-cells together. In all the higher animals and plants these germ-cells are sharply differentiated into male and female, spermatozoa or sperm-cells and ova or egg-cells, and, with rare exceptions, the egg-cell cannot even begin to develop until it has united with, or, as we say, been fertilised by, a sperm-cell. This is very literally the union of two branches of the stream of life.

From the point of view of the theory of heredity, the most important thing about this union is the coming together of two sets of chromosomes—paternal and maternal—the one set coming with the spermatozoon from the male parent, and the other with the ovum from the female parent. The maternal and paternal chromosomes bring with them factors that have arisen in some unknown way, probably by chemical changes, in the two ancestral streams of protoplasm which unite in the fertilised egg. Apart altogether from the much-vexed question of the inheritance of "acquired" characters, which we cannot even touch upon this evening, these factors represent certain experiences which the stream of life has gathered on its journey.

Hence the new organism may exhibit certain characters derived from the father and others derived from the mother, a combination of paternal and maternal peculiarities, while the fundamental features of its organisation cannot be said to be derived from one parent more than from the other. It will resemble either parent just in so far as it starts life with the same potentialities, inherent in the germ-plasm as a whole and in its special factors, and just in so far as it develops under identical conditions. (We must not forget, though the point is not essential to our argument, that the germ-cells may perhaps contain other special factors besides those which have been located in the chromosomes.)

It is a curious fact, and one upon which our social reformers and preachers of equality would do well to reflect more seriously, that the characters, the potentialities for good or evil, of a living being should depend so much upon mere chance. A great deal can be done for the welfare of the individual by improving the conditions under which it lives, as every gardener knows, but nothing can altogether counteract the effects of hereditary tendencies. It is worth while to consider a little more fully how it comes about that chance plays such an important part.

With certain exceptions, which do not affect the general proposition, every cell of the living organism contains, as we have already seen, a double set of chromosomes, one set derived from the male and the other from the female parent. The duplication takes place at the time when the two germ-cells come together to form the fertilised egg, but it is counteracted again by reduction at another period of the life-cycle; otherwise the number of chromosomes in each cell would continue to increase in geometrical ratio from generation to generation, which is clearly impossible. It is at these two critical periods that chance steps in and prepares her surprises.

In the first place it seems to be purely a matter of chance what luck the germ-cells have in their mating, what particular ovum is fertilised by what particular spermatozoon, and, owing to the enormous numbers in which ova and spermatozoa are produced, the possibilities may be almost infinite. In the second place there are many alternative possibilities with regard to the particular factors which any given germ-cell, male or female, may contain. This depends upon which particular chromosomes happen to remain in the germ-cell after the double number has been halved again. In animals this halving takes place at the time when the germ-cells are ripening, shortly before they are ready to unite in the fertilised egg. The maternal and paternal chromosomes in each, differing as regards the factors they contain, pair off during the process of mitosis. The members of each pair then separate, and one of them alone remains in each mature germ-cell. Hence the germ-cells, even of the same individual, come to differ amongst themselves to a practically unlimited extent as regards their factorial constitution. The life of the individual is like a game of cards, in which a very great deal depends upon the shuffling of the pack, and the player has to do the best he can with the hand dealt out to him. He may make a hopeless failure of it, or a great success; but still the stream of life flows on, ever gathering and combining new experiences, ever forming itself into fleeting individualities and leaving them to perish on its banks as it passes on to fresh attempts at self-expression.

The interest of the Mendelian breeding experiments is so absorbing that it is little wonder if more fundamental aspects of the problem of heredity, to which we have alluded in the earlier part of our lecture, have been largely lost sight of in recent years, while the factorial hypothesis has been hailed by some extremists as the all-sufficient explanation of everything. The characters of the organism may indeed be modified by factors in the germ-plasm, just as the character of a loaf may be modified by putting caraway seeds into the dough; but the caraway seeds do not explain the loaf, and the Mendelian factors cannot explain the organism as a whole. There is doubtless a good deal of truth in the old saying that life is made up of trifles; but it is not the whole truth, and the body of a living organism cannot be regarded as merely the sum-total of its unit characters.

Whatever may be their significance from the point of view of the general theory of evolution and heredity, however, there can be but one opinion as to the immense practical importance of the Mendelian investigations. They have already led to the production of many valuable forms of life, more especially plants, that are to all intents and purposes new creations, although their value and novelty may depend merely upon the bringing together of desirable characters in new combinations and the elimination of undesirable features.

Nor are the possibilities of improvement by selective mating confined to our domesticated plants and animals. Hopes are entertained by many enthusiasts, banded together in the interests of what they have thought fit to term the science of Eugenics, of effecting vast improvements in the human race itself by the application of Mendelian principles. It does not seem likely, however, or even desirable, that men and women should ever consent to be guided in their choice of mates by purely utilitarian considerations.

There are many objections to any far-reaching schemes of this kind, but it does seem possible, when once the facts of heredity are generally known, that the exercise of an enlightened public opinion and individual choice may result in the elimination from the stream of human life of many heritable characteristics which it is very undesirable to perpetuate. In extreme cases, such as feeble-mindedness and certain forms of insanity, it may even be necessary for the community to protect itself by legislation against the criminal propagation of the unfit.

What is wanted, first and foremost, however, is education, and I trust that you will agree with me that it is education in biology—the science of life—to which we may most hopefully look for the physical and mental improvement of the human race. Men and women must learn to realise their responsibilities towards future generations from the biological point of view, and it is in this direction that the citizens of a great city like Edinburgh can best help, by generously supporting the cause of education and research as represented by your ancient and world-famed University.

Speech through the Æther.[1]

By SIR OLIVER LODGE, F.R.S.

AN intelligent deep-sea fish would disbelieve in water. It would be too uniform and omnipresent to make any impression on its senses. Near the surface it might encounter waves and currents, but to creatures thoroughly embedded in its depths water would make no display. Such is our own condition with regard to the æther of space. It eludes direct perception; its existence cannot be directly demonstrated; it has to be inferred.

The fish would probably also disbelieve in gravity, since it would not experience it, and some of the hyperintelligent among us, for quite another reason, seem to be following its example; but that is another story. Suffice it to say that direct sensation is but a poor clue to reality unless supplemented by a great deal of reasoning and indirect inferences. Our senses tell us only about

[1] Abstract of a citizens' lecture of the British Association delivered at Edinburgh on September 6.

matter, and to believe in anything else makes some call upon the imagination. By aid of cultivated imagination, however, the permanently deaf may appreciate something of the meaning of music, and the permanently blind may apprehend dimly the beauty of a landscape. So it appears from the experience of Helen Keller.

Let us grant, then, that the æther impinges on us only through our imagination; that does not mean that it is unreal. To me it is the most real thing in the material universe. It is not matter, but it seems to be the stuff of which matter is made. It holds the atoms together, and it welds the cosmos into a coherent whole. It penetrates the pores of matter even into the innermost recesses of atomic structure, and it extends to the furthest confines of visible space. By its aid we see and analyse the nebulæ at distances too vast for anything but mind. Through it, too, we do more prosaic things—we telegraph and we run electric motors—even tramcars—guiding the energy by a wire itself inert. Briefly summarised, the æther is responsible for cohesion, for chemical affinity, for electric and magnetic forces, for light, aye, and, as we learn from Einstein, for gravitation too. Is there anything the æther does not do? Yes, it does not convey sound. Sound is a vibration in matter, not in æther, while light is a tremor in æther, not in matter. We see through the æther; we do not talk through it.

But my subject is "Speech through the Æther," speech by means of what we call empty space. How can that be? How can we utilise the æther for conveyance of sound?

Only by transmutation. The æther has long been used to convey heat, yet heat is a property of matter. Heat from the sun reaches the earth, but it does not travel as heat. At the sun the quiver of the particles is transmitted to the æther, it spreads out as radiation, and where that falls it can excite a similar quiver. The heat disappears in one place, to reappear in another. It travels continuously as energy, but not as heat.

So it is with sound also. The sound-vibrations must be transmuted, must be delivered up to the æther to travel as radiation, and at the distant station it must be received by something which can transmute the energy back to sound again.

The transmutation of heat from matter into ætherial energy was effected by the atoms themselves by mechanism only partially known to us. Through all the geological ages—literally from time immemorial—it has been going on. Not so with sound. No trace of sound reaches us from an exploding star. We see the flash; we hear nothing. To transmute sound into an ætherial tremor and to change it back again into sound at a distant station requires human agency. It needed discovery and invention. Discovery and invention are rife among us though handicapped in their early stages by poverty and lack of opportunity. Only when some practical result is forthcoming does that difficulty begin to disappear. Faith in the power of discovery, latent in not a few of our strenuous youth, would accelerate the process. Faith removes obstacles and gives to genius its chance. Other nations will soon be beginning to realise this if we do not.

Great achievements are not due to one man, but to a succession of workers, each passing on the torch to the next. Each man's life is too short for extensive achievement. The great building rises, stone by stone, but it takes generations to complete—nay, it is never completed.

The long chain of discoverers has no end and no specifiable beginning. One can but pick out a few salient peaks. Nor is it one line only; it is a branching line. Different paths seem to converge on some one goal. It is well to remember great names of recent times—Kelvin, Maxwell, FitzGerald, Hertz, the pioneers on one line, and on another Crookes, J. J. Thomson, and others who are working hard to-day. The first line dealt with the æther and its properties; the second line discovered the nature of electricity.

It is only with scientific principles that I am dealing, not with the technical details of application. Methods of application are protean; many an amateur is acquainted with them, and the subject is advancing so quickly that devices a few years old may hiss the speaker; each twelvemonth teems a new one; but the fundamental principles remain, and one of these is the nature of electricity. It has turned out to be corporeal, atomic, or, rather, electronic. The discovery which closed the nineteenth century was the isolation of the natural unit of electricity. Small almost beyond conception, mobile and active to an extraordinary degree, the electron is becoming our most docile servant. The skill of man has harnessed electrons, and it is by their aid that sound-vibrations can be transmitted to the æther, and, after transit across great vasts of space, can be transmuted back again. In an empty Crookes's tube they can be driven off from matter. From a hot wire they evaporate, and they can be deflected and guided as we wish. Their obedience is absolute and instantaneous; they have next to no inertia or sluggishness of their own, and they obey the slightest force. An electric pole attracts or else repels them, according to its sign, and so their motions can be encouraged or can be checked.

If faced with a positive plate they rush to it; if the plate is negative they retire discouraged. Their journey is itself an electric current, and thus we get an electric current varying and responding to every fluctuating control. Electric oscillations are known. We owe them to Kelvin and FitzGerald. They are of extraordinary frequency—millions of vibrations per second—and they generate waves in the æther, as was shown by Maxwell and Hertz.

Let us, then, arrange a microphone, an ordinary telephone transmitter to which we can talk in the ordinary way, and let the slow sound-vibrations—a few hundred per second—be applied to strengthen or weaken electric oscillations of a few million per second. Thousands of oscillations occur during the time that every sound-wave lasts, and by letting them control a crowd of electrons in an exhausted vessel or vacuum tube their intensity can be controlled by every ripple, every rustle, every shock, and every sibilant which go to constitute human speech; and the radiation emanating from the electric oscillations will then be graduated in intensity so that the waves which travel in the æther shall be strong or weak exactly as the stimulus requires.

Receive the electric waves and convey them to another empty bulb containing again a hot wire giving off electrons; the crowd of particles respond, another current is generated, carved into fluctuations of corresponding strength, and these variations of current, when employed to actuate a telephone, can accurately reproduce the tones of the distant voice.

Roughly and generally that is the plan, and the astonishing feat is carried out by various ingenious devices. I was not specially astonished by the wireless transmission of coarse signals like the dot and dash of ordinary telegraphy. It is no more difficult to send impulses across space than to guide them by wires. What Mr. Marconi has made practical as "wireless" might have come in first, and then wires might have been regarded as an improvement, like speaking through a tube instead of shouting into the open air. Any mechanical sending key and many a mechanical relay can accomplish that, but no mechanical relay could follow the variations of quality in human voice; no agency short of the electron would be quick and docile enough; but with their aid the feat is accomplished, and the electric waves which act as the intermediary can travel a thousand miles or more before being received and once again transmuted.

One more principle I must emphasise. How can the human ear or any instrument follow vibrations of millions a second? It cannot. Only the electron can do that. But suppose that, in addition to the oscillations coming from a distant station, we set up home oscillations in a small subsidiary vacuum tube of nearly the same frequency. Let the incoming waves vibrate a million times, for instance, while our local arrangement vibrates a million *plus* 500. What will happen? They will "beat." They will give 500 beats a second, and that is a musical note. To that we can listen, and upon that the variations of intensity can be superposed.

This is not the first plan adopted. The first plan was the utilisation of crystals and other detectors, such as the Fleming valve, to rectify the oscillation, to check all the negative pulses and utilise all the positive, to let only one sign through. Thus we got the vacuum valve. But soon this was improved by Lee Forest into a magnifier, so that an original impulse, exceedingly weak, could be strengthened a hundred or even a thousand times by using the electrons as relays and putting a number of relays in series.

So also for transmitting, the magnifying device is available. The electric impulses from the first valve, the one directly actuated by the microphone—these need not be given to the æther; they can be used to stimulate another valve, so as to increase their intensity until the waves generated are powerful enough to be allowed to rush across the Atlantic. This they are able to do in a fraction of a second. And there, though what arrives is only a feeble residue, since they have spread far and wide by that time, yet they preserve all their peculiarities intact, every pulse of the speech is retained and can be reproduced, and by adequate magnification can be made easily audible.

Distance is no deterrent; it only enfeebles; it does not confuse and spoil, as it does with a wire embedded in the ocean. The properties of the æther are perfect, and all the fluctuations are accurately conveyed. All that we require is a magnifier to get a convenient intensity, and that the ingenuity of man has supplied. We have learnt to communicate efficiently across space void of matter. Possibilities are thus opened up the end of which no man can foresee.

Variations of Climate since the Ice Age.[1]

By C. E. P. BROOKS.

THE nineteenth century envisaged the Ice age as a remote catastrophe, sharply separated from the changeless present. The past twenty years have reversed that view; geologists and botanists have traced considerable fluctuations of temperature and rainfall extending from the last (Würmian) glacial period into historical times, while archæologists, working backwards from the present, have met them at the dawn of history with conditions appreciably different from those of to-day. In the countries bordering on the North Atlantic at least, the facts have been laid down with security, and it is now the task of meteorologists to elucidate the various distributions of pressure and winds which were associated with these changes of climate.

At the present day the great ice-sheets of Greenland and the Antarctic Continent are occupied by permanent areas of high pressure, and we may infer that the Quaternary ice-sheets of northern Europe and North America were occupied by similar anticyclones, with dry easterly winds on their southern borders. In Europe at least there is direct evidence of this in a belt of "fossil dunes" extending from Russia to Holland; these dunes are crescent-shaped with their convexities to the east, indicating that they were formed by easterly winds. The Atlantic must have been a

1 Abridged from a paper in the Quarterly Journal of the Royal Meteorological Society, July, 1921, pp. 173–94.

centre of storm development then as now, but the anticyclone over northern Europe prevented these storms from taking their present northern track and forced them into the Mediterranean, where they brought increased rainfall and a "pluvial period." These meteorological conditions are indicated in Fig. 1. (The illustrations are reproduced by permission of the Council of the Royal Meteorological Society.) By reference to the estimates of Penck and Bruckner in the Alps and to the "geochronological" work of Baron de Geer in Sweden, this map is considered to represent conditions prevailing until about 18,000 B.C.

The presence of the ice-sheet is attributed to elevation in Scandinavia (see NATURE, vol. 102, p. 335). With the subsidence of the land the ice receded, slowly at first, then more rapidly, but about 8000 B.C. and again at 5000 B.C., when elevation temporarily closed the connection between the Baltic and the Atlantic, there were halts or slight readvances forming the great Scanian and Ragunda moraines. At the same time the Alpine glaciers, which throughout seem to run parallel with the Scandinavian, formed the moraines of the Gschnitz and Daun stadia.

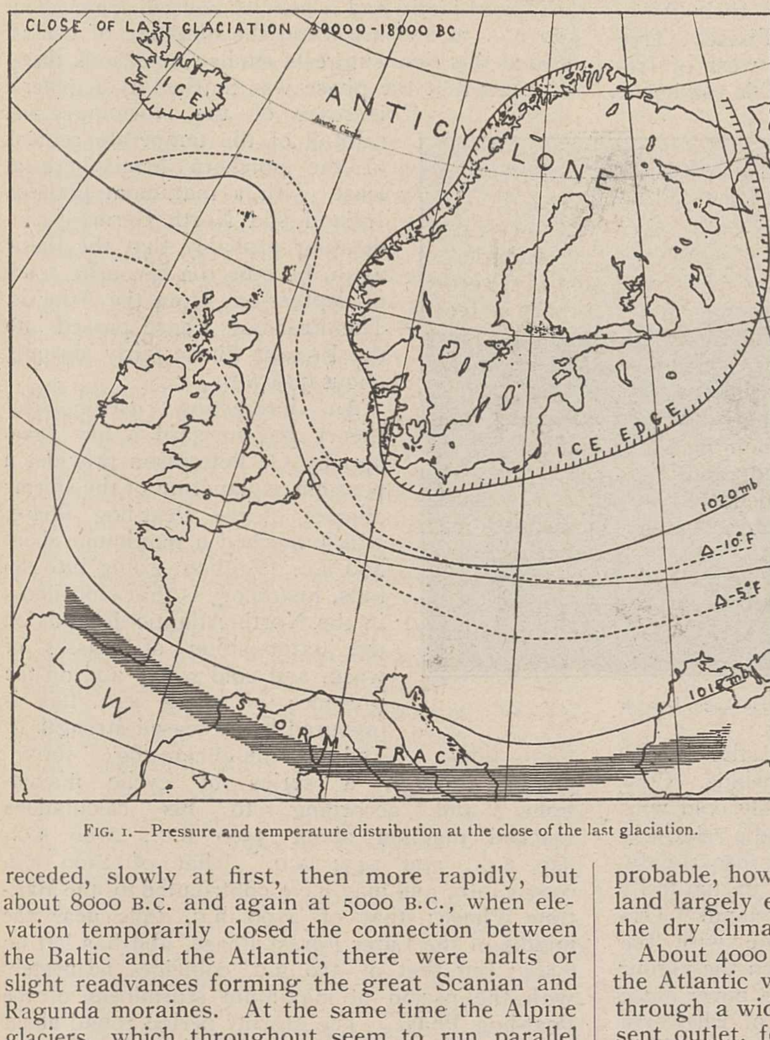


FIG. 1.—Pressure and temperature distribution at the close of the last glaciation.

Until 6000 B.C. the ice-sheet was still large enough to maintain a border of dry Arctic conditions on its southern edge, but the mean annual temperature of southern Sweden rose from 17° F. to 35° F. After 6000 B.C. the Ice age is regarded as over, and the subsequent climatic history can be divided into a series of "phases," as follows:

	Phase.	Climate.	Date.
1.	The Continental Phase	Continental	6000–4000 B.C.
2.	The Maritime Phase	Warm and moist	4000–3000 B.C.
3.	The Later Forest Phase	Warm and dry	3000–1800 B.C.
4.	The Peat-bog Phase	Cooler and moister	1800 B.C.–300 A.D.
5.	The Present Phase	Becoming drier	300 A.D.–Present

About 6000 B.C. elevation closed the outlet to the Baltic for the second time, converting it into the large freshwater *Ancylus* lake. This shutting out of the Atlantic accentuated continental conditions in Scandinavia. The winter climate was severe; at first during the formation of the Ragunda moraines the summers were not especially warm, but later they became hot and dusty. The rainfall was scanty, and the general climate resembled that of South-east Europe. Throughout this phase Scandinavia was occupied by a rich forest flora, and towards the close conditions were very favourable to tree-growth. The hazel extended several degrees north of its present position and to higher levels, indicating a July temperature about seven degrees higher than the present. But the ivy and yew, the limits of which depend on the winter rather than on the summer temperature, showed no such extension, indicating that the winters remained severe. The absence of storms off the north-west coast of Norway is shown by the forests, which at this period covered all the outermost islands as far as the Ingo Islands off North Cape. These islands are now barren, and their afforestation indicates a drier and less stormy climate than the present, with a decreased frequency of winds from the sea. These continental conditions, however, did not extend so far west as Ireland. As the glacial anticyclone decreased in intensity, depressions from the Atlantic began to take a more northerly course, but were held up near the British Isles and materially increased the rainfall there, forming the first peat-bogs of the western coasts. It seems probable, however, that southern and eastern England largely escaped this damp period, sharing in the dry climate of the Continent.

About 4000 B.C. submergence once more allowed the Atlantic waters to flow into the *Ancylus* lake through a wide strait, much broader than the present outlet, forming the *Litorina* sea, which was appreciably larger than the present Baltic, and the Continental Phase gave place to a Maritime Phase, very moist and equable. Depressions now passed freely into the Baltic region, rainfall was heavy, and peat-bogs began to form over extensive areas. This favourable climate was best developed in the Baltic countries where submergence was greatest, but the whole of the North Atlantic and neighbouring parts of the Arctic shared in it to some extent, for raised beaches about 25 ft. above the present level with a warm fauna extended from the east of North America to Spitsbergen and the White Sea. This suggests some general factor which by altering the circulation of the North Atlantic piled up its waters in cold temperate and polar latitudes, producing a period of widespread development of warm maritime climates termed the "Climatic Optimum."

By 3000 B.C. another wave of elevation affected the southern half of the British Isles and neighbouring parts of Europe, which stood about 90 ft. above their present level. At the same time the climate became drier, and a magnificent growth of forests occurred even on the bogs of Ireland, which were extensively inhabited by Neolithic man. Many shallow lakes were more or less dried up and trees grew on their floors (Fig. 2); this is the Later Forest Phase. Tree stools in exposed situations in the west of Ireland, as well as evidence of considerable sea-borne commerce between Scandinavia and the British Isles, testify to an absence of strong winds. Conditions were anticyclonic, with possibly cold winters, but with fine, warm summers and a relatively small rainfall. Neolithic civilisation rose rapidly to its culminating point, especially in naturally moist countries like Norway and Ireland. This period, in fact, appears to coincide with the legendary Heroic age of Ireland, when the vigour of the Irish reached a level they have never since attained, an interesting confirmation of Ellsworth Huntington's theory that at present the high humidity of that country lowers the energy of its inhabitants.

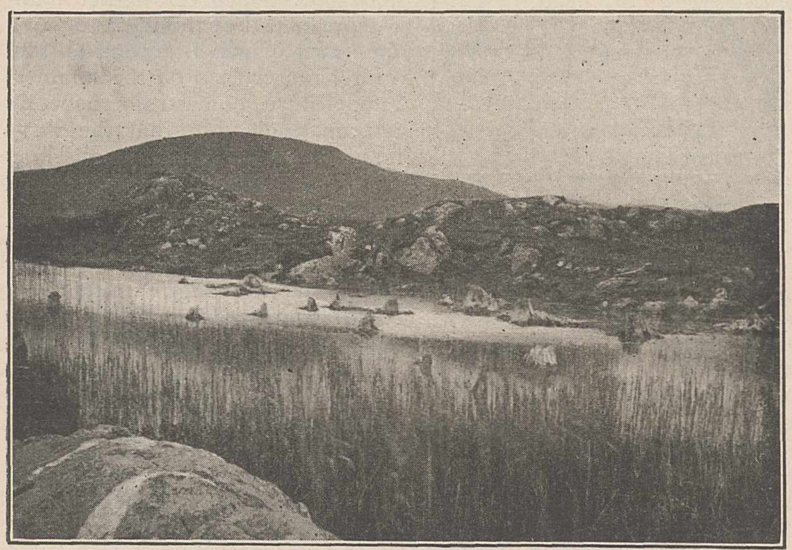


FIG 2.—Submerged tree stools in lough, Ireland.

By 1600 B.C. the land had again sunk to its present level, or possibly a few feet lower. The favourable anticyclonic conditions gave place to great storminess with relatively heavy rainfall, and there set in a period of intense peat formation in Ireland, Scotland, Scandinavia, and North Germany. This growth went on even over high ground which had not previously been covered by peat, for in Ireland tumuli of the Bronze age are found resting on rock and covered by several feet of bog. As the Bronze age gave place to the Early Iron age the climate of North-west Europe became very unfavourable, and the submergence of the early civilisation is described in Norse sagas and Germanic myths—the "Twilight of the Gods," when frost and snow ruled the world for generations (about 650 to 400 B.C.). Peat formation went on even over the Frisian dunes.

This wet period, whatever its cause, was widespread, as is shown in Huntington's curves of tree-growth in California and climate in western Asia; the same author also believes that the Mediterranean lands had a heavier rainfall from about 500 B.C. to 200 A.D., and the quietude of central Asia at this time suggests similar conditions there. It seems that the phase was marked by a general increase of the storminess and rainfall of the temperate regions of the northern hemisphere at least, with a maximum between Ireland and North Germany, indicating probably that the Baltic again became the favourite track of depressions from the Atlantic. The Peat-bog Phase passed into the Present Phase fairly abruptly about 300 A.D.

An interesting astronomical theory put forward a few years ago by O. Pettersson provides a possible explanation of the stormy climate of the Peat-bog Phase, which reached a maximum about 400 B.C. Without going into details, his theory is that storminess in the North Atlantic depends on the juxtaposition of masses of warm and cold water and on the presence of much ice; this is favoured by increased strength of the tides. The "tide-generating force" passes through a series of cyclic fluctuations, and according to his calculations reached maxima about 3500 B.C., 2100 B.C., 350 B.C., and 1434 A.D. That of 2500 B.C. comes into, and may have contributed to, the Maritime Phase; that of 2100 B.C. falls near the middle of the Later Forest Phase, and has left no trace; but that of 350 B.C. coincides accurately with the period of maximum storminess of the Peat-bog Phase. The stormy period round about 1400 A.D. is well known, and has been attributed by other authors to an absolute maximum of sunspots. The corresponding minima were in 2800 B.C., 1200 B.C., and 530 A.D., but of the first of these there is no trace. The second falls in the beginning of the Peat-bog Phase, but there is evidence of seaborne traffic between Scandinavia and Ireland about 1000 B.C., suggesting an absence of storminess. The last minimum, in 530 A.D., was a time of favourable conditions and a revival of civilisation in Scandinavia and Ireland, of little ice and good weather in the neighbouring seas, and of drought in Asia.

Looking back over the whole period since the ice-sheets dwindled to inconsiderable dimensions, we find that there have been considerable variations in the climate of North-west Europe on either side of present conditions, which have been reflected in the ups and downs of civilisation in these regions. The earlier and greater changes are easily explicable at first by the gradual withdrawal of the ice, and then by appreciable changes in the land and sea distribution, but the more recent variations, of smaller magnitude and duration, pass insensibly into the slow fluctuations of the past thousand years, and for these some other cause must be adduced, *e.g.*, Pettersson's, possibly connected with the sun. Such a cause has probably always been in operation, but has been masked by the greater changes of geological time, so that its operation is traceable only in favourable circumstances, or in the magnified perspective of the last thirty centuries.

Obituary.

HENRY WOODWARD.

FULL of years and honours, Dr. Henry Woodward, late keeper of geology in the British Museum, died on September 6 at Bushey, Herts. He retained his faculties almost until the end, and continued to follow with interest the progress of the science to which he had devoted his life.

Henry Woodward was born at Norwich on November 24, 1832, the youngest son of Samuel Woodward, the well-known geologist and antiquary. His father died while he was still a child, and his education at the Norwich Grammar School ended at the age of fourteen, when he went to reside with his eldest brother, S. P. Woodward, who was then professor of natural history in the Royal Agricultural College, Cirencester. Here he pursued studies in natural science, to which he had a decided inclination, and on his brother's removal to London in 1848 as assistant in the British Museum, Henry accompanied him in the hope of obtaining some congenial employment. In 1850, however, he was compelled to return to Norwich and accept a clerkship in Gurney's Bank, where he remained for seven years and devoted himself to natural history only in his scanty leisure. At last, in 1858, he realised his ambition and became assistant in the geological department of the British Museum, where he soon took full advantage of his opportunities for scientific research, and began to make numerous contributions to palæontology. In 1880 he succeeded Mr. G. R. Waterhouse as keeper, and held this office until his retirement from the museum in 1901.

Dr. Woodward's interests were always very wide, and his first publication was a small pamphlet in 1860 on "The Prize Microscopes of the Society of Arts, with Plain Directions for Working with Them." About the same time he began to write semi-popular articles on various new fossils received by the British Museum, and made several valuable contributions to the *Intellectual Observer*, the *Popular Science Review*, and other journals. Among these may be specially mentioned his general account of Archæopteryx in 1862. He continued to prepare notes on new features exhibited by fossils of all kinds added to the museum, and among the earliest was his description of the skull of the mammoth found at Ilford, showing for the first time the true inward curvature of the tusks. He was especially interested in the mammalian remains discovered by Sir Antonio Brady in the Pleistocene deposits at Ilford, and he wrote an introduction to William Davies's catalogue of the collection published in 1874. He also devoted much attention to the later mammalian remains found during the excavation of reservoirs in the valley of the Lea, and he contributed an account of the ancient fauna of Essex to the Proceedings of the Essex Field Club. One of his later papers of the same series contained a description and discussion of a nearly complete skeleton of the extinct Sirenian Rhytina from Behring Straits, which was published by the Geological Society in 1885.

From the beginning, however, Dr. Woodward made a very special study of the Crustacea, and his chief contributions to science are detailed descriptions and comparisons of extinct representatives of this class. In 1863 he published his first paper on a Macruran from the Lias of Lyme Regis in the Quarterly Journal of the Geological Society. From 1865 onwards he prepared several reports on British Fossil Crustacea for the British Association. Between 1866 and 1878 he published his well-known monograph of the Merostomata under the auspices of the Palæontographical Society. In 1877 he contributed to the British Museum catalogues a list of the British Fossil Crustacea. In 1883–84 he wrote again for the Palæontographical Society a monograph of British Carboniferous Trilobites, and afterwards joined Prof. T. Rupert Jones in a monograph of the British Palæozoic Phyllopoda for the same society. So long ago as 1865 he co-operated with Mr. J. W. Salter in a chart of the genera of Fossil Crustacea, and in 1877 he wrote the article on Crustacea for the ninth edition of the Encyclopædia Britannica. He also made a special study of many other arthropoda, and published several papers on insects, arachnids, and myriapods from Carboniferous formations.

Dr. Woodward's influence on the progress of geology and palæontology was by no means confined to his writings. In 1864 he joined Prof.

T. Rupert Jones in founding the *Geological Magazine,* and from the beginning of 1865 until the end of 1918 he was its sole editor. He thus provided a valuable medium for publication, of which due advantage was taken by nearly all British geologists. His kindly advice and able editing encouraged and aided his contributors, and the adequate presentation of the results of much research is due to his experienced guidance. As keeper of geology in the British Museum he also continually stimulated workers, and the series of descriptive catalogues of fossils published under his official direction furnished valuable aids to progress. Nor did he overlook the amateur, whose sympathy and watchfulness can do so much for geology. He added explanatory diagrams and descriptive labels to the exhibited collection of fossils, and made the guide-books more attractive by providing them with illustrations. His genial personality made him hosts of friends, who were ever ready to do the museum such service as was possible.

Dr. Woodward also took an active part in the work of several scientific societies. He joined the Geological Society in 1864, became president in 1894–96, and was awarded the Wollaston medal in 1906. He was elected a fellow of the Royal Society in 1873. For several years he was a member of council of the British Association, and he presided over the geological section at Manchester in 1887. He was an especially active honorary member of the Geologists' Association, of which he was president in 1873–75. He succeeded Prof. Huxley as president of the Palæontographical Society in 1895, and occupied the chair until his death. He was a founder and the first president of the Malacological Society. He also became president of the Royal Microscopical Society, and for many years was one of the vice-presidents of the Zoological Society. He received the honorary degree of LL.D. from St. Andrews in 1878, and was honoured abroad by election to the foreign membership of many societies.

In 1857 Dr. Woodward married Miss Ellen Sophia Page, of Norwich, who was an able helpmate during the whole of his career, and closely associated with him in his work. She died in 1913, and her memory is treasured by those who had the good fortune to attend the frequent hospitable gatherings at her home. The eldest son was for some years Government Geologist of Western Australia, and the second son began a promising career in zoology at the Royal College of Science, but both met with a premature death. One of the five daughters, Miss Gertrude M. Woodward, has rendered valuable service to palæontology by the admirable drawings with which she has enriched many works during the past thirty-five years.

IT is with much regret that we have to announce the death of LIEUT.-COL. SIR PETER JOHNSTON FREYER, which took place on Friday last, September 9. Sir Peter was born in 1852, and received his early education at Erasmus Smith's College, Galway. For his medical training he went to University College, Dublin, where he obtained his M.D. and M.Ch. in 1874; he also studied in Paris. In 1875 he was appointed to the Indian Medical Service, in which he served with distinction for a number of years, being appointed to represent India at the International Medical and Surgical Congress held at Rome in 1894. He was the recipient of the Arnott Memorial Medal in 1904 for original work in surgery. After retiring from the Indian Medical Service Sir Peter set up in practice as a consulting surgeon in London, and also acted as consulting surgeon to Queen Alexandra's Military Hospital and to the Eastern Command. He was best known for his work on surgical diseases of the urinary system, and particularly of the prostate gland, in connection with which he devised the operation now in general use for its removal in cases of enlargement. For his services to the community he was created C.B. in 1917, and advanced to K.C.B. later in the same year.

BY the death of MAJOR G. H. NORMAN, at the Cambridge Hospital, Aldershot, aviation has lost one of its few scientific enthusiasts. An unusual combination of knowledge with expertness as a flyer had marked him out for important research under the Air Ministry, and one of his recent striking successes was the analysis of the causes of fire in aeroplanes, particularly after a crash. The more important defects were soon detected, and remedies for them suggested and put into effect. Before his death the point was reached at which a number of equally probable causes were shown to exist, and attention is being directed to their elimination.

Recognition of Major Norman's activities came early in the war, and his services in developing aerial gunnery were of great value. His efforts led to the simplification of sighting arrangements, and followed from a recognition of the limitations peculiar to fighting in the air.

WE announce with much regret the death, on September 6, of MR. G. W. WALKER, F.R.S., at the early age of forty-seven years.

THE death is announced, on September 8, at the age of seventy-two years, of the REV. J. B. LOCK, senior fellow and bursar of Gonville and Caius College, Cambridge, the author of many well-known school books of mathematics.

WE regret to learn of the death, on August 24, of DR. J. A. ALLEN, for thirty-seven years a member of the staff of the American Museum of Natural History, New York.

THE death took place on September 11, at the age of seventy-one, of MR. R. E. BAYNES, senior student of Christ Church, Oxford, and Lee's reader in physics.

Notes.

THE Edinburgh meeting of the British Association has been successful beyond even the most sanguine anticipations. The membership has reached nearly 2800, and all the sections have been largely attended, particularly during the joint discussions. These have, indeed, been so attractive that apparently the future practical problem will be to find sufficient halls large enough to accommodate the members who wish to be present at them. It is much more easy to provide meeting-places for a number of small sections than several large halls each of which will hold 400 people or so for a joint discussion. The success of the present meeting is largely due to the untiring devotion of Prof. J. H. Ashworth, whose intimate knowledge of the work of the Association made him an ideal local secretary. Sir Edward Thorpe's temporary indisposition, which prevented him from reading his address in person, was much regretted. but we are glad to know that Sir Edward is expected to be about again in a day or two. Next year's meeting at Hull will begin on September 6, and the president will be Prof. C. S. Sherrington, president of the Royal Society. The annual meeting in 1923 will be in Liverpool, and that in 1924 will probably be held at Toronto. The new members of the council of the Association are Dr. F. W. Aston, Prof. H. J. Fleure, Sir Joseph Petavel, Prof. A. W. Porter, and Prof. A. C. Seward.

A GENERAL discussion on "Catalysis, with Special Reference to Newer Theories of Chemical Action," will be held under the auspices of the Faraday Society on Wednesday, September 28, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. The discussion will be divided into two parts. Part 1, beginning at 4.30 p.m., will deal with "The Radiation Theory of Chemical Action," and it will be opened by Prof. J. Perrin. Part 2 will be concerned with "Heterogeneous Reactions." It will be opened by Prof. I. Langmuir. Among those expected to take part in the proceedings are Prof. Arrhenius, Prof. V. Henri, Prof. E. C. C. Baly, Prof. F. G. Donnan, Prof. W. C. McC. Lewis, Prof. A. Lindemann, Prof. A. W. Porter, and Dr. E. K. Rideal. Fellows of the Chemical Society are invited to attend the meeting. Others interested in the subject may obtain tickets of admission from the secretary of the Faraday Society, 10 Essex Street, London, W.C.2.

THE annual meeting of the British Mycological Society will be held at Worcester on September 19–24. On September 21 Mr. Carleton Rea will deliver his presidential address entitled "A Brief Review." On September 22 a discussion will be opened by Dr. E. J. Butler on "The Amateur in Relation to British Mycology," and a paper read by Prof. A. H. R. Buller on "The Chemo-taxis of Slugs in Relation to Fungi." On September 23 a paper will be read by Mr. J. Ramsbottom on "The Origin of Saprophytism in Flowering Plants."

THE Ministry of Agriculture and Fisheries announces that the Official Seed Testing Station for England and Wales has been transferred from Streatham to the National Institute of Agricultural Botany, Cambridge, and that all communications should in future be addressed to the Chief Officer, Official Seed Testing Station, Huntingdon Road, Cambridge.

IN the August issue of the *Journal of Hellenic Studies* Mr. F. N. Pryce describes a remarkable Minoan bronze statuette in the British Museum. The earliest date to which it has been traced is 1885, when it was included in the category of "unclassified or suspect bronzes," but it may possibly have entered the museum a hundred or a hundred and fifty years ago. Only quite recently its significance and value have been realised by comparison with other specimens of Minoan art. The height of the statuette, including the base on which it stands, is 8¾ in. The dress, by comparison with an Egyptian representation of a Minoan envoy on the tomb of Rekhmara at Thebes, belongs clearly to that period. The remarkable feature in the statuette is that instead of the middle hair lock it seems to bear the figure of a snake, which associates it with the Minoan snake cult. The worshipper—for the figure does not represent a deity—is apparently standing in an attitude of stiff reverence before the shrine of the goddess, with whom he enters into communion by wearing her emblem.

IN the August issue of *Discovery* Miss W. S. Blackman gives an account of the mourning rites of Musulmans in the province of Asyut, Egypt. Every Friday women, sometimes accompanied by their male relatives, visit this desert graveyard, wail at the graves, and distribute large basketfuls of bread. Curiously enough, Lane in his admirable account of death rites in his "Modern Egyptians" does not describe this rite, well known in other places, as in India, under the name of Ziyārat, or "visitation." It is obviously a survival of the animistic rite of feeding the dead. The rite, which has been handed down from the ancient Egyptians, is known as Prt, "coming forth" or "going up," and the reproduction which Miss Blackman publishes of an ancient Egyptian painting representing a woman wailing by the tomb of a dead relative closely resembles the photographs which she gives of the custom as it is carried out in modern Egypt.

DURING excavations made at Middleton-on-the-Wolds recently in connection with a whiting works there, a square grave cut into the chalk, which measured 3 ft. each way, was found, and adjoining it a long V-shaped trench. The owner, Mr. E. B. Lotherington, communicated with Mr. T. Sheppard, of the Hull Museum, and the trench was carefully excavated. The grave contained a human skeleton in a crouched position, on one arm of which was an iron bracelet carrying two large bone beads. In the same grave was a massive bone ring made from the thick part of an antler of a red deer. This measures 2¼ in. across and is remarkably well made, resembling the familiar ivory rings from Africa. Pottery found in association with the burial consists of typical grey-ware turned on a wheel, and the rough hand-made dark pottery made from the Kimeridge clay, containing white fragments of grit, etc. The trench yielded numerous pieces of pottery, a part of a red deer antler pick which had been cut by a metal instrument, and bones of horse, ox, pig, sheep, and dog. The remains point to the hill upon which they were found having been occupied by the Romans in the second or third century. The trench excavated was only one of a number visible. The objects excavated have been placed in the museum at Hull.

WITH reference to the Note in NATURE (August 18) describing a catalogue of specimens of tapa or bark-cloth recently acquired by the Pennsylvania University Museum, Mr. Chas. J. A. Howes writes from 36 Havelock Road, Earlham Road, Norwich, that he possesses a copy of this rare work, but the title-page seems to differ in some particulars from that of the Pennsylvania copy. In Mr. Howes's copy specimen No. 18 is described as "the very finest of the inner coat of the mulberry wore (*sic*) by the chiefs of Otaheite." The collector notes, regarding this specimen, that some seamen were sent to fetch fresh provisions, and one of them met some children at play. One of them, a girl, snatched at the red feathers which he had stuck in his cap. He at once took them out and presented them to her. In the evening she came to the shore, and, singling him out from his companions, gave him the piece of cloth from which this specimen was cut—"a true sign of gratitude in these people."

IN a short article contributed to the Memoirs of the Manchester Literary and Philosophical Society (vol. 64, part 2) Major Leonard Munn discusses the ancient mines and megaliths in the Hyderabad State. The writer attempts to cover too much ground in a short paper, but he gives some interesting information. In corroboration of Prof. Elliot Smith's theories, he finds the stone monuments closely connected with ancient gold-mines, but of many of these the sites are now forgotten. Enough remains to show the perseverance and intelligence of the early miners. "Unless anyone has visited Hyderabad State, or, in fact, Southern India, they cannot form any idea of the abundance, the extent, or the pureness of its iron-ores. No section of the geological sequence exists in which iron does not occur."

THE Gold Coast Survey Department, which appears to have been suspended during the war, was re-opened in the latter part of 1919. The annual report for 1920 by the Surveyor-General, Lt.-Col. R. H. Rowe, has now been published, and shows much progress in the Department. The principal work was the completion of the topographical survey of the Colony, of which several sheets have already been produced on a scale of 1 : 125,000. During the year an area of 1200 square miles was surveyed. It is hoped shortly to undertake the reproduction of the sheets in the Colony, and buildings are being erected for this purpose. A school for the instruction of native surveyors was to be opened this year.

THE Geological Survey has just issued vol. 17 of the Special Reports on the Mineral Resources of Great Britain, the present volume being issued under the auspices of the Scottish Branch of the Survey. In this volume an account is given of the occurrence of the ores of lead, zinc, copper, and nickel in Scotland, the bulk of the work having been done by Mr. G. V. Wilson, whilst Dr. J. S. Flett, now Director of the Survey, has written the chapters on Caithness and on the Orkney and Shetland Islands. The work is exceedingly well done, and shows much painstaking study and research. It brings out, however, only too clearly the unfortunate fact that from the economic point of view the occurrences of these ores in Scotland are practically negligible. The only ore which occurs in any noteworthy quantity is that of lead, and this is due to one single mining district, for as such Wanlockhead and Leadhills may fairly be regarded, though the former lies in Dumfriesshire and the latter in the adjoining portion of Lanarkshire. During the period 1850–1920 the total production of lead from Scottish mines was 180,271 tons, of which the mining area above-mentioned contributed no fewer than 172,000 tons, the production from each group of mines being about equal. Similarly, the largest annual output of lead from Wanlockhead is given as 2578 tons and from Leadhills as 2600 tons, whilst no other mine in Scotland has reached an annual output of 400 tons. The present report is, therefore, more interesting from the geological than from the economic aspect, and Mr. Wilson has devoted much attention to the mode of origin of the deposits and to the vein-fillings. A considerable number of the minerals present are secondary in nature, and reasons are given for considering that the reactions causing secondary solution and deposition of certain of the ores are probably still in operation. It is to be regretted that the scope of this report was not somewhat widened so as to include all metalliferous minerals (with the exception of the ores of iron, which have already been fully discussed). This could have been done without adding much either to the labour involved or to the bulk of the report, and it would have been convenient to have had the occurrences of gold, for example, properly classified and fully described instead of finding merely casual references to its occurrence.

THE *Weekly Weather Report* of the Meteorological Office for the week ending August 27 gives a summary of temperature, rainfall, and sunshine for the summer season obtained from the values for the thirteen weeks from May 29 to August 27 for the several districts in the British Isles. The highest mean temperature for the summer in any district was 62·1° F. at the English Channel stations, and the second highest was 61·5° for South-East England. The mean temperature was above the normal in all districts with the exception of North and East Scotland, the greatest excess being 2·3° F. in the Midland Counties. The rainfall was decidedly less than normal except in West Scotland. The least total rainfall for the summer season was 2·04 in. for South-East England, which is 3·98 in. less than the thirty-five-year normal and only 34 per cent. of the average. The next smallest total was 2·20 in. for East England, which is 4·06 in. less than the normal and 35 per cent. of the average. At the English Channel stations the total was 3·83 in., which is 2·52 in. less than the normal and 60 per cent. of the average. Bright sunshine was in excess of normal in all districts except North Scotland, the greatest amount of the possible duration being 53 per cent. at the English Channel stations, followed by 47 per cent. in South-East England and 46 per cent. in South-West England. The Greenwich values for the civil day published in the weekly returns of the Registrar-General give the average temperature, mean of maximum and minimum, 64·2° F. for the three summer months combined, the respective means being June 60·3° F., July 68·5° F., and August 63·8° F. The excess on the average for thirty-five years for the whole summer is 2·2° F., for June 0·4° F., for July 5·0° F., and for August 1·2° F. The rainfall for the three summer months combined was 1·29 in., the total for June being 0·46 in., that of July 0·15 in., and that of August 0·68 in. The deficiency for the summer on the average for 100 years is 5·42 in., and the total is only 19 per cent. of the average. Smaller falls have occurred previously in each month, but only once in July, in 1825, when 0·10 in. fell. The fall for the whole summer is the smallest in the last 105 years, the next lowest being 1·36 in. during the summer of 1818, followed by 2·50 in. for 1864. The sunshine for the three summer months at Greenwich registered 222 hours in June, 286 hours in July, and 179 hours in August, in all 687 hours, which is 92 hours in excess of the normal for the summer season.

CHARTS showing the deviation of the pressure and temperature from normal values for each month and for the year 1910, based on observations at land stations—generally two for each 10° square of latitude and longitude—have just been published by the Meteorological Office under the title of "Réseau Mondial, 1910." The charts have been prepared to illustrate the tables which were issued in 1920, and a similar volume of charts for 1911 was published in 1916. The late war has rendered it difficult at present to obtain data for the later years. This world-wide meteorology will add much to our present knowledge of weather changes, which in many respects are exceedingly intricate; it is by such world-wide information that we may eventually hope to forecast for longer periods than is possible at present, and in time, perhaps, we may foresee the character of a coming season. Atmospheric-pressure lines of equal deviation from normal are given for each five millibars, and for temperature the individual deviations are plotted for each station. In this volume it has not been found possible to represent graphically the deviation of rainfall from normal. Among many other questions of interest, such charts may render it possible to form some idea as to whether the pressure of the atmosphere is always practically uniform over the world as a whole; the charts in question would seem to suggest that it is, but a more detailed examination must be made to substantiate such a conclusion.

THE September issue of the *Philosophical Magazine* contains a paper on "The Effect of Temperature on the Rigidity and Viscosity of Metals" by Messrs. Kei Iokibe and Sukeaki Sakai, of the University of Sendai, Japan, which appeared in vol. 10 of the Science Reports of that University. The method used by the authors is that of torsional oscillations of a wire 25 cm. long and 0·6 to 0·7 mm. diameter suspended vertically in a tube furnace electrically heated to 700°–800° C. In all the thirteen metals tested as the temperature rises the rigidity decreases, according to a parabolic law which would make the value zero at the melting point. The decrease at low temperatures is small for metals with high melting points, but becomes rapid near the melting points in all cases. The viscosity as determined on Honda's theory from the logarithmic decrement of the oscillation increases rapidly as the temperature rises up to the melting point, but in the case of metals with high melting points there is a range of temperature below 100° C. within which the viscosity decreases slightly with rise of temperature.

IN a note on p. 502 of NATURE for June 16 we directed attention to the conclusion of Mr. T. L. Eckersley that the main source of the trouble in the determination of the direction from which a radio message comes during the night is the wave reflected downwards at the under-surface of an outer conducting layer of the atmosphere. In the August issue of the *Radio Review* Messrs. G. M. Wright and S. B. Smith, of the Marconi Research Department, describe observations on the night behaviour of the heart-shaped polar diagram obtained by combining a single frame with a vertical aerial, and find that it agrees with the reflected-wave theory. It shows further that the reflected ray is in a vertical plane and that its angle of incidence is small. In these circumstances the minimum of the heart-shaped diagram gives the correct bearing of the transmitting station, whether night disturbances are present or not.

THE paper on the magnetic electron which Prof. A. H. Compton, of the University of St. Louis, contributed to the American Association for the Advancement of Science in December last is reproduced in the August issue of the Journal of the Franklin Institute. After pointing out that Langevin's theory of diamagnetism is inadequate quantitatively and makes diamagnetism transient instead of permanent, Prof. Compton shows that the evidence is in favour of the negative electric charge being the prime cause of the magnetic property of the molecule. His own observations on the passage of X-rays through, and their reflection from, magnetised crystals show no evidence of the orientation of the molecules by the magnetic field, which present theories of magnetisation postulate. He considers that the electron spinning about an axis through itself like a small gyrostat is more likely to be the ultimate magnetic particle than either the atom or the molecule, and thinks that the spiral form of path which is so frequent in the case of cathode or β-rays in air supports his view.

A FURTHER contribution to the study of the African rift valleys and their world-relations will be issued shortly by Messrs. Seeley Service and Co., Ltd., in a new work by Prof. J. W. Gregory, entitled "The Geology and Rift Valleys of East Africa." Its object is to show the continuity of the rift valley from Palestine to south of the Zambesi, with the exception of a short gap in the southern part of the Tanganyika territory. The work also summarises the volcanic history of East Africa, and shows that the rift valleys have been formed by a series of earth movements connected with the foundering of the Indian Ocean. These movements began in the Cretaceous, and have lasted until quite recent times. Some movements in connection with them are probably still in progress.

THE new list of forthcoming books just issued by Messrs. Methuen and Co., Ltd., contains a number of works relating to the subject of relativity, viz.:—"Space—Time—Matter," Prof. H. Weyl, translated by H. L. Brose; "Einstein the Searcher: His Work Explained from Dialogues with Einstein," A. Moszkowski, translated by H. L. Brose; "An Introduction to the Theory of Relativity," L. Bolton; "Relativity and the Universe," Dr. H. Schmidt, translated by Dr. K. Wichmann; "The Ideas of Einstein's Theory," Prof. J. H. Thirring; "Relativity and Gravitation," by various writers, edited by J. M. Bird; and "The Fourth Dimension Simply Explained," a collection of essays selected from those submitted in the *Scientific American's* prize contest, with an introduction and editorial notes by Prof. H. P. Manning.

Our Astronomical Column.

THE BRIGHT OBJECT OF AUGUST 7.—*Astr. Nach.* No. 5118 contains a further observation of this object made at Plauen, Vogtland, by the daughter of Prof. E. Kaiser and several others. It appeared like Venus at its greatest brilliancy, low in the evening sky shortly after sunset. Its position with regard to distant terrestrial objects was accurately noted. At G.M.T. 7h. 35m. its azimuth was 98° 22·6′ from south to west, and its apparent altitude 2° 35·9′, or 2° 21·9′ corrected for refraction. Plauen is in N. lat. 50° 29′ 45″, long. E. Greenwich 12° 7′ 11″; Prof. M. Wolf deduces that the R.A. of the body was 11h. 6·7m., N. decl. 7° 9′. This gives longitude 165·0°, N. lat. 1° 20′. It may be mentioned that the place of Jupiter was R.A. 11h. 23·9 m., N. decl. 5° 6′, but it does not seem possible that this could have been the body observed.

The Lick Observatory position at G.M.T. 15h. was about R.A. 9h. 22m., N. decl. 15·8°, or longitude 138°, N. lat. 0·4°.

It is to be noted that the object observed in England was much closer to the sun (estimates of distance 6° and 4° respectively) than the Plauen object, so that an element of doubt remains. But the latter observation was made in a much more exact manner, so it deserves greater weight. If we assume the identity of the Plauen and Lick objects, and that the motion was parabolic, then the maximum distance from the earth on August 7 was 0·005 in astronomical units, or about twice the moon's distance. It appears unlikely that a comet at this small distance would have such a well-defined stellar appearance.

EINSTEIN'S REAL ACHIEVEMENT.—The *Fortnightly Review* for September contains an article with the above title by Sir Oliver Lodge, in which he alludes to the awakening of interest in relativity brought about by Einstein's visit to England and the publication of Lord Haldane's book, which extends the doctrine to a wider field than that of kinematics.

Sir Oliver Lodge notes that the more ardent relativists treat the subject from a purely geometrical point of view, and endeavour to eliminate all reference to physical laws. For example, they suggest that the speed of a falling apple may be equally well attributed to the earth, and that the diurnal rotational movement may be ascribed to the heavenly bodies themselves. They minimise their references to the æther, some of them denying its existence. He deprecates these methods of treatment as unlikely to lead to advance in our knowledge of the universe. For his own part he expresses an ardent belief in the reality of the æther and its association with electricity and matter. He gives a brief *résumé* of the work of Clerk Maxwell (extended by Larmor, Lorentz, and Thomson), referring in particular to the relation connecting the electrostatic and electromagnetic units with the velocity of light, and passing on to the Lorentz-FitzGerald contraction, which plays an important part in the equations of relativity.

He urges the retention of the Newtonian conception of force in celestial mechanics, the simple law of inverse squares being amplified by the addition of the terms arising from the change of inertia with motion. He expresses his admiration at the skill which has succeeded in reducing the action of forces to formulæ in pure geometry; nevertheless, he considers that one is thereby introducing complexity and departing from the realities of Nature. However, throughout the article there is nothing but praise for Einstein's achievements, and criticism is merely directed against the method of expressing them.

NEBULAR LINES IN SPECTRUM OF R AQUARII.—The detection of the bright nebular lines at 4363, 4471 (helium), 4658, 4959, and 5007 superposed on the Md spectrum of this star was announced in 1919 by Mr. Paul Merrill, who gives an account in the *Astrophys. Journ.* for June of his further researches on the spectrum. Four spectra are reproduced, three of which were taken about a month before maximum (magnitude 8·3 to 7·0), and the fourth forty-seven days after minimum (magnitude 10·2). The first three show a continuous spectrum with the customary lines and bands of the Md type, together with the five bright lines. The fourth shows the bright lines quite as strongly as at maximum, but there is no trace in the reproduction of a continuous spectrum, and it is noted that it was practically absent even with considerably longer exposures.

There is also a comparison of the displacements of the two spectra on the plates taken near maximum. The Md bright lines give −33 km./sec., Md absorption lines −19, nebular lines except 4363 −10, and 4363 nebular −25. A statistical investigation on the stars of Md spectrum is being undertaken in the hope of determining whether the bright lines or the absorption ones, or neither, give the correct radial velocity. Many of them, including Mira Ceti, give the same relative displacement of about 14 km./sec.

Mr. Merrill suspects that the appearance of the nebular lines in the spectrum of R Aquarii may have taken place quite recently. He has examined the Harvard objective-prism spectrograms (dating from 1893). These lines are not observable on them.

British Roses and Hybridity.

THE genus Rosa, along with the brambles (Rubus), hawkweeds (Hieracium), and certain other polymorphic genera, has long furnished serious problems to the systematic botanist. Darwin spoke of the kind of variability which these genera show as "independent of the conditions of life," meaning that the differences exhibited are "of no service or disservice to the species," and are therefore not directly subject to natural selection. Modern geneticists would largely agree with that point of view.

In two recent papers (*Annals of Botany*, vol. 35, p. 159, and Trans. Nat. Hist. Soc. Northumberland, Durham, and Newcastle, vol. 5, part 2) Dr. Harrison and Miss Blackburn have thrown a great deal of light on the polymorphic condition which has long puzzled students of British roses. Their results are based on a careful study of the roses of northern England in the field and a cytological investigation of their chromosomes. This type of combined cytological and experimental investigation has already elucidated the nature of the variability in such genera as Œnothera and Drosophila, and its application to other groups is probably the most promising field in present-day genetics.

Contrary to the early studies of Strasburger, the fundamental haploid number of chromosomes in the genus Rosa is found to be seven. In *Rosa arvensis* and related forms the diploid (2×) number of chromosomes is fourteen. These forms show normal fertilisation, and the meiotic divisions are free from irregularities. The group of forms to which *R. pimpinellifolia*, L., belongs is tetraploid, the somatic number of chromosomes being twenty-eight (4×). In these forms also the meiotic divisions are for the most part normal, and fertilisation is necessary. These two groups of roses form a parallel to the diploid and tetraploid types in species of Œnothera, and since tetraploidy is known to have originated by mutation in Œnothera, it has probably originated in the same manner in the roses. The group of roses known as Villosæ is also tetraploid, but that these roses have originated in another way, probably as hybrids, is shown by the behaviour of their chromosomes, for instead of forming fourteen pairs in the reduction division there are seven pairs and fourteen single chromosomes.

Perhaps the most interesting are the pentaploid (5×) roses, of which four groups are recognised, containing such species as *R. sylvestris, R. rubiginosa,* and *R. coriifolia.* These have thirty-five somatic chromosomes and twenty-eight in the reduction division. Of the latter bodies seven are pairs or bivalents and twenty-one singles or univalents, thus making up the full number. The bivalents are almost invariably arranged in a central group surrounded by the univalents. These pentaploid roses have probably all originated through crossing, as is indicated by the behaviour of their chromosomes, among other things. The reduction divisions following this manner of chromosome pairing show the familiar irregularities in the distribution of their chromosomes, with the result that the pollen is almost wholly sterile. Dr. Harrison has also shown experimentally that these forms will set seed apogamously, although producing fertilised seeds in the same flower. The presence of apomixis, of course, accounts for these roses coming true from seeds.

The diploid roses and the Pimpinellifoliæ, which are sexual, are, on the contrary, looked upon as pure species. In accordance with the views of Ernst in a book on apogamy, published during the war, the presence of apogamy is regarded as a result of the stimulus of hybridity to vegetative development. The authors would explain the origin of many British hybrid roses of this type through northern forms belonging to the Afzelianæ clashing with the southern Eucaninæ, owing to climatic changes occurring perhaps at the beginning of the Glacial period. Other hybrids are probably being formed even now, and since the Afzelianæ are themselves pentaploid (5×) they must be the product of still earlier crossing. Thus it seems clear that a large proportion of our rose species are ancient hybrids the characters of which are perpetuated by apomictic reproduction.

Mr. J. R. Matthews (*New Phytol.*, 1920, p. 153) has also made a systematic study of British rose hybrids, and Miss Cole (*Bot. Gazette*, 1917) has examined the pollen of American roses.

These and similar results obtained in recent years raise several important questions. The first is, of course, the part played by crossing in connection with evolution. The most extreme views on this subject have probably been held by Lotsy and Jeffrey. Both agree in believing that hybridisation occurs practically throughout the Angiosperms. The former, however, would attempt to explain all evolution as the result of crossing, while the latter holds that hybridisation and hybrid forms can have played no part whatever in evolution. In this connection it seems well to remember that in open-pollinated plants the evolutionary unit will be a group of interbreeding forms differing from each other in various characters, the differences being perpetuated by the crosses between individuals which are made each year. Crossing between related forms is then a condition under which evolution has taken place not only in open-pollinated plants, but also in animals. It does not necessarily follow, however, that crossing is the *cause* of that evolution. Dr. Harrison and Miss Blackburn conclude that "hybridity is one of the prime factors in the evolution of species," if not the only one. Their own results with the tetraploid (4×) roses of the group Pimpinellifoliæ, however, indicate that after the tetraploidy originated (whether through the stimulus resulting from crossing or not), germinal changes, *i.e.* mutations, must have occurred, giving rise to the present group of tetraploid forms. Again, the occurrence in various rose species of microgenes differing from each other in having full green or glaucous foliage, glabrous or hairy leaves, etc., can probably be best interpreted as the result of what we now call parallel mutations rather than indicating orthogenesis, as Dr. Harrison suggests.

Viewing these and related facts as a whole, it seems clear that while mutation and crossing are almost inextricably intermingled in the history of many plant genera, yet it does not follow that crossing is the cause of mutation. Even if this were the case, they should still be regarded as separate phenomena. It is a curious fact that in Drosophila, where the sexes are separate and crossing of individuals must therefore take place in every generation, no one seems to have tried seriously to explain the mutations as a phenomenon merely of hybridisation. This is probably because the evidence appears strong that many of these mutations had their germinal origin at about the time they appeared as external characters, *i.e.* in the immediately preceding generation of germ-cells.

Another point of general interest in this connection relates to the pollen sterility of hybrids. Jeffrey and his pupils have claimed that the presence of "bad pollen" is a proof of hybridity. This is the revival of a much older view, and studies of the pollen of Epilobium, Œnothera, Rubus, and other genera have been cited in support of this contention. Some of the results have been severely criticised by systematists, who have shown that in certain cases only one species exists in a region where the presence of bad pollen is supposed to have proved hybridisation. Messrs. Brainerd and Peitersen have made a study of the New England Rubi (Vermont Agric. Expt. Sta. Bull. No. 217), in the course of which they find much hybridisation and no forms with entirely good pollen; they are therefore inclined to accept this dictum. That "bad pollen" is unsafe as a criterion of hybridity is shown, however, by other results. For example, Profs. Gates and Goodspeed (*Science*, 1916, p. 859), examining the pollen of various Californian species, found a variable proportion of bad pollen in *Trillium giganteum*, the nearest relative of which is in the Eastern States; *Dirca occidentalis*, the only other species being in eastern North America; and *Scoliopus Bigelovii*, a remarkably isolated genus of Liliaceæ, the only other species of the genus occurring much farther north.

That sterility or fertility of pollen is an inherited character has been shown in the sweet pea by Bateson and in the velvet bean (Schizolobium) by Belling, and it is reasonable to conclude that the occurrence of bad pollen may result not only from crossing, but also from mutation and from physiological or environmental conditions.

Geography in Austria.

By PROF. GRENVILLE A. J. COLE, F.R.S.

THE Geographical Society of Vienna continued its octavo *Mitteilungen* througnout the war-years, though the style *kaiserliche königliche* perforce disappeared from its title with the issue of No. 12 in November, 1918. Few contributions could be expected from Austrian travellers in unusual fields, but the reviews of current exploration in all parts of the globe have kept the members up to date. The editors in 1914 were Drs. Fritz Machatschek and Hermann Leiter. The former became sole editor for 1915, and the latter acted from 1916 onwards. One naturally looks at first for special studies arising out of war-conditions. As early as October, 1914, Oberstleutnant Josef Paldus (vol. 57, p. 395) reviewed the system on which maps are grouped in the Kriegsarchiv in Vienna. This collection is rich in materials for students of history, and is by no means restricted to maps that will help modern armies in the field. It originated in an official military library formed by Prince Eugene of Savoy, whose frequent crossings of the Alps, and campaigns from Douai to Belgrade, must have impressed him deeply with the value of cartography. The kindly autocrat Joseph II. organised a detailed survey of the Austrian lands, remarking that to rule well required an accurate knowledge of the country. So long as he lived the collection of geographical material was carried on in a most liberal spirit. The position of Austria soon caused its military cartography to extend over adjacent lands, and Viennese maps are still our best authorities for a large part of the Balkan States. The sheets of the beautiful map of central Europe, on the scale of 1 : 200,000, which are frequently revised, are, moreover, among the best aids to travellers in southern Germany, northern Italy, Bosnia, and Poland. Oberstleutnant Paldus gives the date of inception of this series as 1907; but the Szombáthely sheet was issued in 1897, and the present writer used many others in road-journeys between Vienna and Sarajevo in 1899. The previous 1 : 300,000 map, remarkable in its time, seems to have escaped mention.

During the recent war Austrian observers were able to penetrate Albania from the north. Baron Nopcsa (vol. 59, p. 520, 1916) has utilised his collection of maps for an interesting summary of cartography in the region, beginning with the coast of "Dyrrachio" about A.D. 250. The paper is illustrated by numerous drawings from maps of the Cattaro-Dulcigno district, coming down to 1914. Eugen Oberhummer (vol. 61, p. 313, 1918) describes a journey with other members of an intelligence-bureau during the occupation of Montenegro and Albania. He directs attention to the map of Serbia, 1 : 75,000, completed by that State in 1888; this was repeated, from 1897 onwards, by an Austrian edition, in which the names are in Roman characters. Albania remained unsurveyed; Baron Nopcsa looked forward to the publication of Austrian work done during the war. Meanwhile, many things have happened, and the region has again eluded the embrace of an interested group of nations. Oberst Hubert Ginzl (vol. 61, p. 497) illustrates, by reproductions from the older sheets and the coloured and contoured new editions, the immense improvements made in the maps of Serbia and Albania under the stress of war. The older issues might guide troops along the highways, but were found useless for tactical dispositions. E. Nowak (vol. 62, p. 211, 1919) describes progress made by the war-geologists eastward from Durazzo and Valona. One wishes that peaceful international relations could ensure the completion of the good work thus begun.

In vol. 61, pp. 609–40, and vol. 62, pp. 25–40 (1919), six authors discuss, from various points of view, morphological, climatic, faunistic, and anthropological, how far natural boundaries can be assigned to Poland as marked out by the peace-terms. H. Praesent, in the anthropogeographical article, points out how the boundary between different types and grades of culture strikes the eye as one enters Poland—at Illowo, for instance—in the absence of any morphological feature. Even Galicia, with the glorious city of Krakow as a centre, has hung behind from a material point of view. The matter is not entirely due to political conditions. Anyone who knows the village inns, as compared even with those of Hungary, will agree that Praesent's observation is not inspired by race sentiment. Indeed, such sentiment as is allowed within the walls of the Geographical Society of Vienna seems directed towards a distant and hypothetical England, figuring as a corsair on the seas.

Anthropologists, such as Josef Weninger (vol. 61, p. 143, 1918), took advantage of the prisoners' camps to study unfamiliar folk. The Georgians are especially complimented on their understanding and on their sympathy with the spirit of research.

Among historical studies Hans von Voltelini (vol. 59, p. 181, 1916) gives a valuable account of the origin of the southern boundaries of Austria before the war, which, of course, serves to rectify some current judgments. There are, for instance, writers who forget that Trieste escaped in 1382 from warfare with Venice to the security of Habsburg rule, and remained under this "domination" for more than five hundred years. The Austrians, however, did not become long-distance seamen until the sixteenth century. Prof. Eduard Zenker contributes papers on the Roman roads of Austria. "Karnuntum—Vindobona" (vol. 60, p. 507, 1917) reminds us of how Rome is still remembered. We halted one golden evening at the little inn of Petronell, and praised the wholesome quiet of the spot. "Yes," replied the ostler, "Marcus Aurelius loved it well." It was not until the next morning that we saw the ruins of Carnuntum by the road.

As an example of European study we may note that Fritz Machatschek (vol. 60, pp. 235 and 274) describes the southern flanks of the Erzgebirge. This chain must no longer be regarded as an Armorican anticlinal ridge, but has been determined by successive bulgings of the floor from Lower Oligocene times onwards. Terrace-regions on the south represent portions of the main gently curved surface that have been lowered by faulting, and the well known volcanoes that produce such variety in the landscape are manifestations of earth-movements that continued into the Quartary (Quaternary) era. The evidence of such movements is seen in the stages by which the Eger Valley has been deepened. To turn to farther fields, economists and politicians will find much of interest in H. Leiter's review (vol. 62, pp. 414 and 433, 1919) of the present railway-system of Africa. The unfinished Cape-to-Cairo route now offers few attractions in view of the proposed cross-cut from Bukama, its present terminus, to the Congo mouth, a point quickly reached by sea from England. The numerous recent developments from the coasts of the Mediterranean, the Red Sea, and the Indian Ocean are described, and the dry details soon link themselves together as a romance. "Un tourbillon de sable," we once said to our guide, looking south over the Sahara, where a cloud rose among the dunes. "Pardon, monsieur," he replied, "c'est le chemin de fer." The railway was going forward to Touggourt.

The comprehensive paper by C. Diener on "Die Groszformen der Erdoberfläche" (vol. 58, p. 329, 1915) concludes that continental blocks and ocean-basins have shown permanence, at any rate since Permian times. Such work takes us into wider fields than Eugen Oberhummer's interesting discussion of imperialistic policies (vol. 63, p. 101, 1920) or H. Hassinger's well reasoned attempt to define the boundaries and the qualities of a Middle European region (vol. 60, p. 437, 1917). Both these essays in political geography provide much food for thought, and Hassinger's remark on the mixture of races between the Straits of Dover and the Black Sea is worth quoting: "Reiner Nationalstaat und Panslawismus sind Mitteleuropa fremd und wirken hier unnatürlich."

More illustrations are needed for papers dealing with natural features; but this defect must not be charged against those who have done their best to advance knowledge through the war-time.

Valence.

IN an article on "Types of Valence" in *Science* for July 22 Dr. Irving Langmuir develops still further the views on this subject which are associated with his name. He points out that the term "valence" has been used to describe (1) *positive valence*, or the number of electrons an atom can give up; (2) *negative valence*, or the number of electrons an atom can take up; and (3) *covalence*, or the number of electrons an atom can share with its neighbours. He brackets the first two under the name of "electrovalence," and accounts for them by the tendency to form a *complete layer* of 2, 8, 8, 18, 18, or 32 electrons (First postulate). The outer *incomplete* layer of electronegative elements, such as oxygen and the halogens, which tend to take up electrons, is distinguished as a *sheath*, and this term is used even when the atom has taken up electrons, so that the outer layer has become for the time a *completed sheath* in the negatively charged ion. The same term is also used in the case of the electropositive elements to describe the small excess of electrons which are lost when the atom becomes a positively charged ion.

The simplest complete layer consists of two electrons (*e.g.* in He or H+) in close proximity to a nucleus; such a pair of electrons is called a *duplet*, and this term is extended to include any pair of electrons which is rendered stable by its proximity to one or more positive charges. The third type of valence is then controlled by the second postulate that "two atoms may be coupled together by one or more duplets held in common by the completed sheaths of the atoms."

Since each duplet eliminates two electrons as compared with those required to form a pair of complete sheaths, it follows that the algebraic sum of the electrovalences and covalences for all the atoms in any *complete compound* (*i.e.* a compound in which the sheaths of all the atoms are complete) is zero. Complete compounds without covalence include NaCl, $BaBr_2$, K_2S; MgO, BN, Al_2O_3; AlF_3, PCl_5, SF_6, etc. In these last compounds the halogens have seven electrons on the sheath of the atom, and therefore an excess of seven positive charges on the "kernel" (*i.e.* the atom *minus* the sheath), which creates a very strong attraction and enables these atoms to drag away as many as five electrons from an atom of phosphorus and six from an atom of sulphur. When no positive atom is present the electrovalence of every atom must be negative; no atom can lose electrons, and only covalence can exist. In this case the ordinary use of structural formulæ is legitimate; when electrons are transferred instead of being shared it is not. Since the sheaths of atoms of atomic number less than about 25 never contain more than eight electrons, the covalence of these atoms can never exceed four. With heavier atoms larger covalences may occur occasionally, *e.g.* in $Ni(CO)_4$, $Fe(CO)_5$, and $Mo(CO)_6$ the number of atoms in the sheath of the metallic atom is 10, 8, and 6, or 8, 10, and 12 less than the number required to make a complete sheath of 18 electrons. We therefore have negative valences of 8, 10, and 12, as indicated by the formulæ of the three carbonyls.

Incomplete compounds, containing atoms with incomplete sheaths, are particularly abundant in intermetallic compounds where only electropositive atoms are present, each with a sheath very far from complete. Thus in the two long periods 18 electrons are needed to complete the sheath, whilst, as a rule, only 4 can be lost (maximum positive valency equals 4) in order to remove it; there are therefore 14 elements which are compelled to retain electrons in the outer layer, and very few of these can complete their sheaths. These elements are, therefore, exclusively metallic in character, and even their compounds with electronegative elements usually contain loose electrons in incomplete sheaths and often exhibit metallic conductivity. The small and irregular positive valences of the transition-elements of the two long periods depend on the fact that their sheaths contain from 5 to 13 electrons, of which, as a rule, only 2, 3, or 4 can be detached to make a kathion.

The article is ingenious and suggestive, and represents a distinct advance in the process of explaining why and how combination between atoms takes place.

T. M. L.

University and Educational Intelligence.

BIRMINGHAM.—Under the will of the late Mr. Morton, of Moseley (who, in response to the University's appeal for funds, gave 10,000*l.* last year), a sum of 2000*l.* is left to the University for the foundation of scholarships.

The *Birmingham Post* of September 10 publishes a letter from the Vice-Chancellor (Sir Gilbert Barling), the Principal (Mr. C. Grant Robertson), and the Dean of the Faculty of Medicine (Mr. W. F. Haslam) to the Board of Management of the Birmingham General Hospital, in which is pointed out the serious effect on the clinical teaching of the students of medicine which will arise from the closing of two wards of the hospital. In a sympathetic reply the Board states that it is with the greatest reluctance that the wards have been closed, but the failure of voluntary contributions to meet the increase in cost of upkeep of the hospital has left no alternative. It is much to be desired that the public will realise the seriousness of the situation and that the necessary funds may be forthcoming to enable the wards to be reopened.

GLASGOW.—Mr. S. Horwood Tucker has been appointed to the lectureship in organic chemistry.

LONDON.—The programme of University extension lectures for the coming session has just been issued. Courses of lectures will be given and classes held at about seventy local centres in different parts of London and the surrounding district. The subjects treated cover a wide range, and lectures in the departments of literature, history, science, art, architecture, and economics are included in the list. Amongst the courses is a series of lectures on "Some Problems of Modern Biology," to be delivered by Dr. W. B. Brierley at Gresham College.

MR. R. M. C. GUNN, of Montrose, has been appointed lecturer in veterinary anatomy and surgery in the University of Sydney.

IT is announced in *Science* of August 26 that by the will of the late Frances Appleton Foster, of Weston, Massachusetts, the Massachusetts Institute of Technology will receive the sum of one million dollars and Wellesley College, Massachusetts, half a million dollars.

LEEDS UNIVERSITY has issued as a small pamphlet a prospectus of evening courses in technology which will be available at the University during the coming academic year. In the departments of civil, mechanical, and electrical engineering advanced courses extending over four or five years are provided; they are intended to meet the requirements of the examinations for membership of the Institutions of Civil, Mechanical, and Electrical Engineers respectively. A four years' course on coal-mining, designed to enable miners to qualify for managers' certificates, and special courses on dyeing and leather manufacture will also be given. An interesting feature of the pamphlet is the section dealing with "Courses Qualifying for Research Work and Trade Investigations." Lectures and demonstrations will be arranged with the idea of training students in the methods of research adopted in the textile industries, and, as a general rule, only students over twenty-two years of age will be admitted.

IN the prospectus for the session 1921–22 of the Technical College, Bradford, full particulars are given of the courses of instruction which will be given during the coming year. Three- or four-year courses leading to the college diplomas are provided in the departments of textile industries, chemistry, dyeing, and civil, mechanical, and electrical engineering. All these courses have been modified so that students for college diplomas may now present themselves for degree examinations at London University. Part-time courses, consisting chiefly of evening work, will also be given in the various departments. These lectures are provided principally in order to meet the needs of students who are employed in technical industries during the greater part of their time. Research work can also be undertaken at the college, and it is anticipated that when the new engineering laboratories, in which accommodation will be provided for heat treatment, metallography, oxy-acetylene and electric welding, etc., are available, this side of the activities of the college will receive a big impetus.

A USEFUL idea which has been adopted by Battersea Polytechnic is to issue an abridged calendar of the afternoon and evening classes provided during the coming session. It consists of 18 pages, but in that small space the authorities have contrived to indicate the subjects which will be dealt with, the lengths of the various courses, and, in many cases, a time-table of the lectures. A brief account of the full-time day courses is also given. Full instruction in preparation for London University examinations in science and engineering is provided in both day and evening classes, while there are also day courses in mechanical, civil, and electrical engineering, chemistry, physics, and sanitary science which lead to the college diplomas in the various subjects. Evening courses of similar scope are also to be given. In addition, special courses for honours students in chemistry have been arranged; Dr. F. W. Aston will lecture on atomic weights and isotopes, Dr. S. S. Zilva on enzyme chemistry, Mr. Greenberg on the microscopy of foods and drugs, and Mr. A. R. Pearson on the technology of fuels. Research by students of post-graduate standing is permitted only when the accommodation required is not such as to interfere with the routine work of the polytechnic. The pamphlet can be obtained free of charge on application to the Principal, Battersea Polytechnic, London, S.W.11.

THE sixteenth report (for the year 1919–20) of Leeds University, which has recently been published, provides a brief but interesting account of the many activities of the University, together with some interesting figures relating to the cost of University education. Taking the University as a whole, the cost per student for the past year was about 75*l.* This figure is less than that for the year 1913–14 by some 7*l.* The fall in the cost is accounted for by the fact that the number of students has greatly increased, while the salaries of the professorial staff, as we have said repeatedly in these columns, shows but a relatively small increase. However, of this 75*l.* the average fee paid by the student is 27*l.*, leaving some 48*l.* per head to be found by the University. An analysis of the total income available for 1920–21 reveals the fact that 36·1 per cent. was provided by students' fees, 32·7 per cent. by Government grants, 16·4 per cent. by grants from local education authorities, and 14·8 per cent. by endowments, subscriptions, etc. The most noteworthy gift was a sum of 4000*l.* from the Clothworkers' Company of London, which brings the total of that company's list of benefactions to the University to no less than 77,250*l.* Some valuable plant and machinery have also been presented by various engineering firms. The officials responsible for the finance of the University are to be congratulated on the fact that, in spite of building new lecture-rooms and laboratories and making other costly extensions, the University will enter upon the year 1921–22 without a deficit in its accounts.

Calendar of Scientific Pioneers.

September 15, 1883. Joseph Antoine Ferdinand Plateau died.—A valuable contributor to physiological optics and molecular physics, Plateau was trained under Quetelet, and from 1835 to 1871 held the chair of physics at Ghent. From 1843 he was totally blind.

September 16, 1736. Gabriel Daniel Fahrenheit died.—German by birth, Fahrenheit became an instrument-maker at Amsterdam. His improvements in thermometers consisted in the use of mercury, the introduction of the Fahrenheit scale, and the substitution of elongated bulbs for round ones.

September 16, 1869. Thomas Graham died.—Distinguished mainly for his investigations in physical chemistry, Graham from 1837 to 1855 held the chair of chemistry in University College, London, and was the first president of the Chemical Society. He discovered the law of the diffusion of gases, and to him we owe the terms "crystalloid," "colloid," "dialysis," and "atmolysis."

September 17, 1783. Leonhard Euler died.—Though born in Basle and trained in mathematics by Jean Bernoulli, Euler passed most of his life at St. Petersburg and Berlin. One of the greatest mathematicians and physicists of the eighteenth century, his works have been described as a perfect storehouse of investigations on every branch of algebraical and mechanical science.

September 17, 1836. Antoine Laurent de Jussieu died.—Carefully trained in medicine and botany by his uncle Bernard, de Jussieu in 1789 published his "Genera Plantarum," a volume which formed the basis of modern botanical classification. The Musée d'Histoire Naturelle was reorganised by him in 1793.

September 17, 1877. William Henry Fox Talbot died.—A graduate of Trinity College, Cambridge, Talbot from 1822 contributed scientific papers to the Royal Society, but is most famous for his pioneering work in photography. He was the first to produce positives from negatives, and invented the "Calotype" process. His apparatus has recently been given to the Royal Photographic Society, and it is proposed to set up a memorial to him at Laycock Abbey, Wiltshire.

September 18, 1896. Armand Hippolyte Louis Fizeau died.—An early worker on photography, Fizeau also made many investigations on light and heat, and in 1849 determined the velocity of light by measuring the time it took to travel between Suresnes and Montmartre, a distance of 28,334 ft. He was awarded the Rumford medal in 1866, and from 1878 was a member of the Bureau des Longitudes.

September 19, 1710. Ole Römer died.—The discoverer of the finite velocity of light, Römer was born in Jutland, became a pupil of Erasmus Bartholin, worked with Picard, and spent the years 1672 to 1681 in Paris. He made known his great discoveries to the Paris Academy of Sciences in 1675. Returning to Copenhagen as a professor of mathematics and astronomy, he there set up the first modern transit instrument. Practically all his manuscripts and instruments were destroyed by fire in 1728.

September 19, 1761. Pieter van Musschenbroek died.—A well-known Dutch experimental philosopher, Musschenbroek held chairs at Duisburg, Utrecht, and Leyden, and added greatly to the knowledge of the physical properties of bodies.

September 21, 1576. Girolamo Cardano died.—One of the most interesting figures connected with the revival of science in Europe, Cardano was a physician, astrologer, and mathematician, and held positions at Pavia, Milan, and Bologna. His chief mathematical work is his "Ars Magna," published at Nuremberg in 1545. E. C. S.

Societies and Academies.

Paris.

Academy of Sciences, August 29.—M. Léon Guignard in the chair.—M. **de Séguier**: The primitive quaternary group of collineations of order 25920 and the Hessian group.—J. **Chazy**: Curves defined by differential equations of the second order.—S. **Carrus**: Triple orthogonal systems.—G. **Bertrand**: Newton's law and Einstein's formula for the perihelion of the planets.—L. **Gentil**: The phenomenon of mounds (*rideaux*) and solifluction. These mounds are frequent in the region between the Somme and the Bresle, and have been attributed by the author to superficial slipping of siliceous clay softened by rain. The *frane* of R. Almagia and the *solifluction* of J. G. Anderson are considered as particular cases of a phenomenon which in France leads to the formation of *rideaux*.—E. **Zaepffel**: Mobile starch and geotropism. It was proved experimentally that in an apparatus containing the substances present in the plant-cell (water, amylase, sugars, and starch) the concentration of the sugar became unequal, with a maximum in the immediate neighbourhood of the starch grains. In the plant-cell, with the starch grains resting on the semi-permeable protoplasmic membrane, this change of concentration in sugar causes modifications in the osmotic relations between the different cells which explain the movements of the tissues.—J. **Pottier**: Observations on the chromatic masses of the cytoplasm of the oosphere in *Mnium undulatum* and *M. punctatum*.—W. **Koskowski** and E. **Maigre**: The peripheral origin of the hyperthermia produced by methylene-blue.—W. **Kopaczewski**: Surface tension and the suppression of shock by sodium hyposulphite. Details of experiments proving that sodium hyposulphite reduces the increase of surface tension caused by the addition of distilled water to serum.—G. **Bourguignon**: Modification of the chronaxy of the motor nerves and muscles by reflex repercussion.

Sydney.

Linnean Society of New South Wales, July 27.—Mr. G. A. Waterhouse, president, in the chair.—Dr. R. J. **Tillyard**: Mesozoic insects of Queensland. No. 8. Hemiptera Homoptera (continued). The genus Mesogereon, with a discussion of its relationship with the Jurassic Palæontinidæ. Additional material comprising three forewings and fragments of two hindwings has been found. In addition to the single species of Mesogereon already known, four species are described as new. It is concluded that Handlirsch was wrong in considering the Palæontinidæ to belong to the Lepidoptera, and that the general build of the insects, the venational scheme, the armature of the wing, and the structures of the margin show that the Palæontinidæ are closely related to the genus Mesogereon, and that both have a less close connection with the recent Cicadidæ.—G. D. **Osborne** and W. R. **Browne**: Note on a glacially striated pavement in the Kuttung series of the Maitland District. The striated pavement described provides evidence of the presence of land-ice which previously had been indicated solely by the presence of glacial conglomerates and varves. The direction of the striæ is N. 13° W.–S. 13° E., the ice having moved in a northerly direction. The floor over which the ice moved is composed of a biotite-dacite, and is overlain by well-laminated varve-rock.—T. **Steel**: The occurrence of calcium oxalate in the Gidgee wattle, *Acacia Cambagei*. The bark of this tree contains 18·8 per cent. (dry) of calcium oxalate, the highest amount recorded for any plant. The timber contained an average of 4·77 per cent. The barks of a number of other species of Acacia were found to contain from 1·36 to 8·92 per cent. of oxalate, thus resembling the Eucalypts.—G. F. **Hill**: *Coptotermes Raffrayi*, Wasman (fam. Termitidæ). This Termit was described in 1900 from specimens of the soldier caste. From the examination of a nest series of imagines, soldiers, and workers and two series of soldiers and workers the validity of Wasman's species is now definitely established.

Books Received.

Relativity and the Universe: A Popular Introduction into Einstein's Theory of Space and Time. By Dr. H. Schmidt. Authorised translation by Dr. Karl Wichmann. Pp. xiii+136. (London: Methuen and Co., Ltd.) 5*s*. net.

All About Pets: Told in Stories. By Lilian Gask. Pp. 224. (London and Sydney: G. G. Harrap and Co., Ltd.) 6*s*. net.

Joe Strong: The Boy Wizard. By Vance Barnum. Pp. 189. (London and Sydney: G. G. Harrap and Co., Ltd.) 3*s*. 6*d*. net.

Records of the Botanical Survey of India. Vol. 6, No. 9. Useful Plants of the District of Lakhimpur in Assam. By H. G. Carter and D. N. Carter. Pp. 353–420+ix. (Calcutta.) 1 rupee.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 15. Training for the Public Profession of the Law. Historical Development and Principal Contemporary Problems of Legal Education in the United States, with some Account of Conditions in England and Canada. By A. Z. Reed. Pp. xviii+498. (New York City.)

Results of Meteorological Observations in the Five Years 1916–20 made at the Radcliffe Observatory, Oxford, under the Direction of Dr. A. A. Rambaut. Vol. 52. Pp. xiii+115. (Oxford: Humphrey Milford; London: Oxford University Press.)

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 19. Lead and Zinc Ores in the Carboniferous Rocks of North Wales. By B. Smith. Pp. iv+162+3 plates. 5*s*. 6*d*. net. Vol. 21. Lead, Silver-Lead, and Zinc Ores of Cornwall, Devon, and Somerset. By H. Dewey. Pp. iv+72. 2*s*. 6*d*. net. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.)

Aggregation and Flow of Solids: Being the Records of an Experimental Study of the Micro-structure and Physical Properties of Solids in Various States of Aggregation, 1900–21. By Sir George Beilby. Pp. xv+256+34 plates. (London: Macmillan and Co., Ltd.) 20*s*. net.

Edinburgh's Place in Scientific Progress. Prepared for the Edinburgh Meeting of the British Association by the Local Editorial Committee. Pp. xvi+263. (Edinburgh and London: W. and R. Chambers, Ltd.) 6*s*. net.

Handbuch der biologischen Arbeitsmethoden. Abt. xi., Methoden zur Erforschung der Leistungen des Pflanzenorganismus. Teil 2, Heft i., Lieferung 13: Spezielle Methoden a/Pflanze. Pp. 186. 54 marks. Abt. v., Methoden zum Studium der Funktionen der Einzelnen Organe des Tierischen Organismus. Teil 3, Heft i., Lieferung 18: Entwicklungsmechanik. Pp. 218. 66 marks. Teil 3, Heft ii., Lieferung 33: Entwicklungsmechanik. Pp. 219–440. 72 marks. (Berlin und Wien: Urban und Schwarzenberg.)

Aus dem Archiv der Deutschen Seewarte. XXXVIII., Jahrgang, 1920, Nr. 6. Strömungen und Oberflächentemperaturen im Golfe von Guinea. By Dr. J. Janke. Pp. 68+7 tafeln. (Hamburg: Hammerich und Lesser.)

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1920. Pp. 39. (London: H.M. Stationery Office.) 1*s*. net.

Hints to Travellers, Scientific and General. Edited by E. A. Reeves. Tenth edition, revised and corrected. Vol. 1: Surveying and Practical Astronomy. Pp. xv+470. Vol. 2: Meteorology, Photography, Geology, Natural History, Anthropology, Industry and Commerce, Archæology, Medical, etc. Pp. vii+318. (London: Royal Geographical Society.) 2 vols., 21*s*. net.

British Labour: Replacement and Conciliation, 1914–21. Being the Result of Conferences and Investigations by Committees of Section F of the British Association. Part 1: On Replacement. Co-ordinated and revised by Miss L. Grier and Miss A. Ashley. Part 2: On Conciliation. Edited by A. W. Kirkaldy. Pp. xxxv+266. (London: Sir I. Pitman and Sons, Ltd.) 10*s*. 6*d*. net.

Transactions of the Royal Society of Edinburgh. Vol. 52, part 4 (No. 32). On Old Red Sandstone Plants, showing Structure, from the Rhynie Chert Bed, Aberdeenshire. Part 4: Restorations of the Vascular Cryptogams, and Discussion of their Bearing on the General Morphology of the Pteridophyta and the Origin of the Organisation of Land Plants. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 831–54+5 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 6*s*. 6*d*.

Introduction to Textile Chemistry. By H. Harper. (Life and Work Series.) Pp. ix+189. (London: Macmillan and Co., Ltd.) 3*s*. 6*d*.

CONTENTS.