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School Science.

THOSE in touch with educational circles have been aware for some time past of a growing dissatisfaction with the scope and treatment of school science. The Report of the Committee of the British Association upon Science in School Certificate Examinations[1] thus comes at an opportune moment, and will be welcomed by all who realize the difficulties of the present position. It is not an easy matter to probe to the root of the widespread feeling that all is not well with science in the schools, but at bottom there seems to be a conflict between utilitarian and æsthetic ideals. Many teachers, recognizing that the majority of their pupils will have to work hard for a living, feel that they must be given instruction of immediate practical value ; others emphasize the importance of training young people to appreciate to the full the serene joys of the intellectual life. These two aims are not necessarily incompatible, and their reconciliation might be effected with reasonable ease, were not the situation rendered almost hopelessly rigid by the incubus of examinations.

There are in England and Wales eight examining bodies which conduct First and Higher School Certificate examinations, taken by boys and girls at the ages of 16 and 18, or thereabout, respectively. Through the activity of the Secondary School Examinations Council, these several examinations have been closely equated, and there is now little variation among them in syllabus and standard. This uniformity is in many ways a good thing, but the disastrous result of a comprehensive yet stereotyped examination system has been to stifle originality in teaching, and to raise the list of examination successes into a fearful idol, to be at once worshipped and dreaded. The effect upon science has been particularly devastating, owing to the special circumstances. Science is a comparative new-comer to the school curriculum, and a mere half-century's experience has proved insufficient to enable teachers to work out the most suitable and efficient means of teaching it. Yet, while still in this immature state, school science is becoming petrified by examination requirements, and the evil habit of 'cramming' is likely to establish itself firmly unless immediate steps are taken to prevent the catastrophe.

The Committee not only points out the danger, but makes valuable suggestions for avoiding it. It favours a scheme whereby schools may arrange

[1] British Association Reprints. No. 23 : Report on Science in School Certificate Examinations. Pp. 443-532. (London : British Association, 1928.) 1*s*.

their own plan of work, and examine their own pupils in association with independent boards of assessors. Such a scheme is already in operation in certain technical schools, where a national certificate is awarded under the joint supervision of the Board of Education and the Institution of Mechanical Engineers; and a similar scheme has been adopted by the University of London for the examination of the twenty-two training colleges allotted to it. If a system of this kind were generally adopted, with adequate safeguards, teachers would have far more freedom to elaborate methods and courses of work suited to particular needs, and school science would have the opportunity of advancing on the lines of true culture.

Present conditions are responsible for a further regrettable tendency in elementary science teaching, namely, a concentration upon formal chemistry, physics, and, to a less extent—principally in girls' schools—botany. Although something may be said for such a study at the stage of the Higher Certificate, it is very doubtful whether boys and girls of 14 to 16 really derive any great permanent benefit from a diluted form of academic science. The 'theory' of chemistry and physics, and even of botany, is in fact not appropriate to the general education of the middle school. A few bright pupils may benefit, but teachers and examiners alike realize that most of the candidates are drowned in a boundless sea of definitions, laws, and hypotheses, of a depth to them unfathomable.

Still another conspicuous defect in school science is the infrequency with which biology forms a part of the regular routine. Whatever we may regard as the primary aims of teaching science to boys and girls, we must certainly include among them that of imparting an elementary knowledge of the phenomena of life. It is therefore extremely disconcerting to find that many, if not most, of our children may pass through the schools without receiving any instruction whatever in biology. There are, of course, explanations of this remarkable state of affairs. In the first place, the majority of science teachers have specialized in chemistry or physics, or both, at the universities, and are thus content, in general, to teach those subjects only; at any rate, no active demand for biological work is likely to proceed from teachers of the exact sciences unless a stimulus is applied from without. Secondly, it has been—and is—maintained that biology has too recently emerged from the purely descriptive stage to lend itself to the inculcation of scientific method, whereas chemistry and physics may be very easily adapted to this end. Lastly, we are reminded that biology is based largely upon chemistry and physics, and that logic consequently demands a study of at least the elements of the two latter sciences as a necessary preliminary to biological work. It is clearly an urgent matter for the biologists to show how these difficulties can be removed.

Such are the principal facts relating to the present condition of science in schools. It remains to consider them in relation to the strife between æsthetic and utilitarian ideals which we believe to be the real cause of the prevailing controversy. Since modern civilization depends for its very existence upon the application of scientific knowledge, no one will deny the importance of teaching young citizens a modicum of scientific facts. Moreover, technical occupations absorb increasingly large numbers of workers, and must continue to do so as long as civilization persists: it may thus be of direct practical and financial value to a boy or girl to get elementary technical instruction at as early an age as possible. These two points are, in brief, the arguments of the utilitarian school, and they undoubtedly have much weight. If they carry the day, they will tend to preserve the existing scheme of formal chemistry and physics, and to exclude biology until biological callings have increased to such an extent as to offer wide and immediate prospects.

Even those teachers, however, who most strongly urge the utilitarian aims agree that science, as part of a general education, should do more than impart useful information. There is, in fact, an almost universal feeling that the æsthetic side of science is ultimately the most vital, but opinions differ as to the degree and manner in which this aspect is to be emphasized. Stern disciplinarians, who themselves experience an austerity of pleasure in fundamental scientific philosophy, make superhuman efforts to transmit some shadow of this pleasure to restive school certificate sets; the rare occasions on which their labour gets the full appreciation it deserves are a sufficient recompense for many failures. It is a commonplace that such teachers are usually regarded with no little reverence by their pupils in after years, but the reverence is rather for the man than for his teaching.

There are, again, those teachers who strive 'to make science easy', and in doing so run dangerously near the borderline of insipidity: scientific facts, as such, are of no greater educational worth than the date of Waterloo or the names of Henry VIII.'s wives. To know how an electric bell works is not necessarily to be educated. It is seductively

attractive to make one's science course a series of superficial explanations of devices and phenomena, and to imagine that one is revealing the beauties of science.

This has been the chief criticism levelled at 'everyday science', 'science for all', or 'general science'; but it is a criticism easily disposed of, since it rests upon a misunderstanding. The advocates of 'general science' have been envisaged as those who would replace the very real (if limited) benefits of formal science by the illusory returns of a shallow smattering. Nothing could be farther from the truth. 'General science', as properly interpreted by the Committee, is an attempt to make children see science steadily and to see it whole; to enable them to assimilate scientific principles and scientific method by a consideration of phenomena from the point of view of every relevant branch of science; and to increase their capacity for intellectual pleasure by opening to them the inexhaustible treasures which science discovers in the world of everyday life. The 'general scientists', in fact, are thorough-going supporters of the æsthetic aim, though sometimes they disguise their real sentiments by pointing out the immediate practical value which the course they suggest may possess. It is true that a scheme of 'general science' may include lessons on severely practical topics, but the whole spirit of the course is to relegate the purely utilitarian aim to a definitely lower place.

Unfortunately, 'general science' has to fear two extremely serious perils. The first is that it can so easily be transformed into a grotesque caricature, becoming, indeed, the smattering which it strives to avoid. The second is that it is incomparably more difficult to teach than the formal chemistry or physics or botany at present in vogue. If it is to achieve its purpose, the first essential is to dispel the notion that 'general science' is a soft option, to be welcomed for the sake of weaker candidates, but otherwise to be disparaged. This difficulty in teaching will, we fear, be very troublesome to overcome, but examining bodies may do something by encouraging schools to take general science, and by allowing a wide choice of questions in the papers.

Specialization at the later stage, that of the Higher Certificate, is probably inevitable. Yet we admit surprise at the qualified blessing which the Committee gives to the Higher Certificate Examination, for we cannot bring ourselves to believe that it is good for boys and girls of 16-18 to devote three-quarters of their school time to the study of only two or three special subjects. We should like to see a broader basis for the examination, with a less intensive treatment. Similar remarks apply to the university scholarship examinations, which demand what is practically degree knowledge from the candidates, and do more to sophisticate adolescent education than any other single factor. E. J. HOLMYARD.

The Place of Science in our View of History.

The History of British Civilization. By Dr. Esmè Wingfield-Stratford. Vol. 1. Pp. xv + 574. Vol. 2. Pp. viii + 575-1332. (London: George Routledge and Sons, Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 42*s*. net.

ON several occasions the pages of NATURE have afforded evidence of the growing importance taken by science in the writing and teaching of history. It is, in fact, at the root of the difficulty which was dealt with recently in one of the leading articles. How to secure that our political leaders—and one might well add leaders of all other kinds—should approach their business in a scientific spirit? There are, of course, many ways by which the change will come, and is coming, but it may be doubted whether any way will affect a larger number of persons than that of infusing the ordinary teaching and view of history with some notion of the part that science has played in the process. For we all learn some history. Not only at school but also in after life, so far as we do any serious reading at all, it is of a historical kind; floods of memoirs and biographies are being constantly poured out by the press.

Here is the main source of intellectual influence which is playing upon the more thoughtful sections of the public; it is here that science must make its way. It is therefore an interesting study—more interesting every time—to measure the space which science occupies in works of general scope, especially when they purport to talk of civilisation as a whole, and, most of all, of modern civilisation. Such a book has just appeared in Mr. Wingfield-Stratford's "History of Civilization", which has had a remarkably good press and promises, if he can induce his publishers to produce a cheaper edition, to have a powerful influence in forming British opinion about its own past. It has all the elements of sound popularity for an English public, a vigorous full-blooded style, a freedom of personal judgment, an absence of pedantry or the apparatus of learning, a readiness to admit national crimes and defects, and a glorious ending on the right side, with the British Commonwealth of

Nations standing for the cause of humanity, and encompassed by the greater League of all nations.

It is a capital and most interesting book, well deserving its success. But we are looking at it here from the special point of view of science, and in that respect it marks an advance, and yet, even perhaps more strongly, shows where the next advance must follow. Some six or eight short sections out of 1300 pages are given to an account of the men of science themselves, who, except Roger Bacon, are justly appreciated, and the right place of science, in first accelerating and then controlling the Industrial Revolution, is well indicated. This is something to be thankful for, much more and in a better spirit than in the books of our youth, where we were lucky if we found Newton mentioned at all, even as Master of the Mint.

It is still very inadequate, however, and we should like to make the inadequacy patent to Mr. Wingfield-Stratford and any other open-minded writer of books on history by two considerations, one of a particular and the other of a general kind. To take the particular example first. He gives us pages of a highly amusing and instructive kind on the progress of Mr. Bernard Shaw to fame, his shameless self-advertisement, his gibes and clever plays. He does not do this on account of his socialism, for it does not appear that the author is a socialist. He does it because of its personal interest and because in the end Mr. Bernard Shaw did attain the notoriety at which he aimed. No doubt also it is one of the reasons why we find the book so interesting. Now just at this time one of the greatest pieces of scientific construction in the history of mankind was going on, the development of the new astronomy which has given us the amazing view of the universe which fills the mind of all who have approached it with a fresh unquenchable curiosity and the profoundest admiration for its creators. It happens that the two most prominent names in this army are Englishmen, Jeans and Eddington, and their work must have a lasting influence on the way we both think and act. Yet in the book before us there is not a word about it.

That is one of many cases which might be quoted from a book in which the general spirit of the author is quite favourable to science. If these things are done in the green tree——? The general criticism connected with this is more intangible and may not carry conviction so readily to every mind. This book, and most surveys of modern history, end on a note of poignant resignation, not of despair but of horror and uneasiness, of hope against hope. We believe this tone to be largely due to the divorce of the literary mind from science. The literary mind being personal, sensitive, and often ephemeral, is naturally obsessed by the suffering and tragic conflicts of the War. It is right that we should have these things brought prominently before us. A heartless science would be worse than untutored savagery. But it is essential that those who aim at putting forward a general view of human progress, which is what a 'history of civilisation' must mean, should have regard to the dominant and lasting factors.

On this view, what is the most striking fact about the world towards the end of the nineteenth century and the beginning of the twentieth, above all in the throes of the War? Surely its stability in spite of conflict, its recovery in spite of stupendous loss. Were a stranger from Mars to visit this planet without a knowledge of what we have gone through in the last fifteen years, he would not report a scene of desolation or decadent idleness or internecine strife, but a hive of industry, a network of intercourse, a fertility of invention, and a range of thought which, on inquiry, would appear far to exceed anything in the human record. The black spots, such as parts of China and Russia, would also on inquiry be found to be precisely those places where the organisation, provoked and carried out by scientific thinking, were the least developed.

It is curious that this, which will certainly be the most commonplace observation about twentieth century civilisation by the historians of the future, is at present so rarely made. It is due no doubt to the political and still more the literary preoccupation of the bulk of contemporary historians. The League of Nations is gradually but with difficulty fighting its way into the pages of history and the everyday thinking of mankind. But the foundations of the League, which lie much more in the cultural, economic, and scientific region than in the declarations of statesmen, have still to be dragged into the daylight. The activities of commerce and transport, the agreements as to disease, hygiene, slavery, and the like, above all the supreme constructions of the mind, such as the new cosmogony instanced above, are all international and—in the broad sense—scientific, and, until the historians come to their work with a mind awake and to some extent instructed on this side, justice will not be done to the most vital aspects of the modern world. Above all books, a 'history of civilisation' should give due place to these things, for what is modern civilisation if we leave out science?

F. S. MARVIN.

Statistical Mechanics.

Statistical Mechanics : the Theory of the Properties of Matter in Equilibrium. Based on an Essay awarded the Adams Prize in the University of Cambridge, 1923–24. By R. H. Fowler. Pp. viii + 570. (Cambridge : At the University Press, 1929.) 35*s*. net.

THE motion of a given conservative dynamical system is a problem which can be reduced to the consideration of the properties of the functions defined by its Hamiltonian equations of motion. These equations are themselves deduced by allowing infinitesimal departures of the system from its actual course. In an endeavour to base the laws of thermodynamics on mechanical grounds, Maxwell, Boltzmann, and Clausius were led to consider assemblies of similar systems, each possessing its own configuration and velocities. Even were it possible to describe minutely the configuration at a given time of each member of an assembly consisting of a large number of such systems, it is doubtful whether our senses would be acute enough to appreciate the implications of such a description.

There is, however, another direction in which such inquiries may be pursued, namely, in an investigation of the law of distribution at a given instant of all the systems among the various possible configurations and velocities. The number of systems which fall within given infinitesimal limits of configuration and velocity will in general depend not only on the generalised co-ordinates and momenta, but also on the time. Where this dependence does not involve the time, we have statistical equilibrium. The problem which is now of paramount interest is the search for the normal or time-average properties of such an assembly. The only method of finding these averages which is amenable to exact treatment appears to be an identification of them with averages taken over the accessible phase-space of many dimensions by means of which the configuration and velocities of the assembly may be described.

The average value of statistical mechanics may be regarded, as indeed they were by Boltzmann, Gibbs, and Planck, as values of maximum frequency of occurrence. Mr. R. H. Fowler prefers to obtain them by assigning 'weights' rather than probabilities, a method which leads to a more rigorous mathematical treatment. As the immediate object is to treat statistical problems from the point of view of the classical quantum theory, this theory is regarded as fundamental, and classical systems are introduced as the limit, for large quantum numbers, of quantised systems. This unusual procedure is justified by the remark that the laws of quantised systems cannot be obtained from those of classical systems. The rules for assigning weights and the definition of normal properties as averages over the accessible phase-space are of course the crux of the whole matter; they may even be looked upon as a postulation of the solution. No attempt is made to disguise this logical hiatus, and it would seem that some such gap must always arise in the application of a mathematical theory to the physical world. It is, indeed, an advantage that the crucial assumptions should not appear in a more subtle way.

The rules for weighting are as follows :

(i) To each element of phase-space of a classical system is attached a weight proportional to its extension, namely,

$$(dp_1 \ldots dq_s)/h^s.$$

(ii) To each mechanically possible stationary state of a non-degenerate quantised system is attached a weight unity.

(iii) To each state of a degenerate system is attached a weight equal to the number of different stationary states of some non-degenerate system which coalesce under adiabatic transformation in the limit to form the given state of the degenerate system.

No general proof has been given that the weight of a degenerate system so defined is unique, nor is a general rule available for counting the non-degenerate states. This can scarcely be called a defect of the method, but is rather a limitation on our present state of knowledge. These weights are adiabatic invariants in the sense of Boltzmann. A simple example of an adiabatic invariant was given by Einstein in 1911, namely, the ratio of the mean kinetic energy of a simple pendulum to its period when the string of the pendulum is shortened infinitely slowly.

Having arranged a system of weighting, the next step is to calculate average values. This is done by constructing partition functions, which in the simplest cases are power series, the coefficients of which are the weights. The average values are expressed as contour integrals involving these partition functions, and these integrals are then evalued by the method of steepest descents. This is an extremely elegant and powerful mode of attack, and it is significant that the parameter ϑ which presents itself in the application of the

method can be interpreted as a function of the absolute temperature T, the actual relation being $\vartheta = e^{-1/k}$, where k is Boltzmann's constant. Gibbs considered assemblies of classical systems canonically distributed in phase, that is, those in which the index of probability is a linear function of the energy and containing a 'modulus of distribution' analogous to the temperature. The partition functions are the generalisation for quantised systems of the phase integrals of Gibbs.

After applying the above considerations to obtaining the statistical distribution laws of perfect gases, crystals, radiation, etc., the relation of thermodynamics to the equilibrium theory of statistical mechanics is established by showing that thermodynamical laws are true for the assemblies considered. An extremely interesting and searching criticism is given of the method originated by Boltzmann and extended by Planck of introducing entropy by relating it to probability, a method which is claimed to be "obscure or misleading and certainly unnecessary". The author's argument is cogent and deserves to be read with care, but it is certainly surprising that the method has passed so long unchallenged.

From this point the theory is developed in numerous aspects; Nernst's Heat Theorem, imperfect gases, thermionics, stellar interiors, to mention a few of the topics treated. Dr. Lennard-Jones has contributed an interesting numerical survey of intermolecular forces. The author's object has been throughout to develop a consistent theory completely, and this object has certainly been achieved. The bearing of the new mechanics has been summarised in the last chapter, the important result being found that the accessible phase-space of the classical theory must be cut down to states appertaining to a selected group of wave-functions.

The leading comprehensive treatise in English on the statistical mechanics of an assembly of classical conservative dynamical systems is that of J. W. Gibbs, published in 1902. Since that date mechanical ideas have travelled far, and in the light of the new mechanics we have now to talk of a classical quantum theory. Mr. Fowler has written a worthy successor to the work of Gibbs, and it is to be hoped that, when the time is ripe, it will be followed by a treatise based entirely on the new mechanics. Until that time arrives the present volume must remain the most authoritative source of information on the subject as a whole.

L. M. MILNE-THOMSON.

Statistics in Biological Research.

Statistical Methods for Research Workers. By Dr. R. A. Fisher. (Biological Monographs and Manuals, No. 5.) Second edition, revised and enlarged. Pp. xii + 269. (Edinburgh and London: Oliver and Boyd, 1928.) 15*s*. net.

WITH the increasing application of statistical methods to new fields of work, the problem of the handling of small samples has become more and more important. It is true that the larger the sample the more trustworthy are the inferences which can be drawn from it, but there are certain problems, whether biological or industrial, in which the time and cost involved in obtaining even a moderately large sample would be quite prohibitive. This need for a development of small sample theory has emphasised the importance of placing the methods of inference on a clearly defined and logical basis. For loose thinking and careless interpretation are both easier and more dangerous when dealing with small than with large samples. The aim of the statistician must be to bring the simplifying assumptions of theoretical analysis into correspondence with the varied and complex situations of practical work.

Dr. Fisher sets out in the introduction to this book, of which a second edition has been published recently, what may be termed his statistical philosophy. It may not perhaps be easy to follow at a first reading—perhaps not before his mathematical papers published elsewhere have been read and if necessary interpreted in more familiar terms—but a grasp of the ideas involved is essential to a clear understanding of his methods. These are perhaps, after all, more like those criticised than he will allow, but the line of approach is somewhat different. His aim has been to develop on systematic lines a series of tests appropriate for use in a great variety of problems. This has involved a very considerable extension of theory, based in several cases upon a most elegant use of the geometry of multiple space. These proofs are not, of course, given in the present book, which is primarily intended for biological research workers, but the practical applications of the methods to a variety of problems are given with numerical illustrations, and the necessary probability tables.

To discuss how far the author has achieved his object of putting clearly before the research worker the means of applying statistical tests, would require perhaps a reviewer who is a non-mathematical biologist. There is one criticism, however, which must be made from the statistical point of

view. A large number of the tests developed are based upon the assumption that the population sampled is of 'normal' form. That this is the case may be gathered from a very careful reading of the text, but the point is not sufficiently emphasised. It does not appear reasonable to lay stress on the 'exactness' of tests, when no means whatever are given of appreciating how rapidly they become inexact as the population sampled diverges from normality. That the tests, for example, connected with the analysis of variance are far more dependent on normality than those involving 'Student's' z (or t) distribution is almost certain, but no clear indication of the need for caution in their application is given to the worker. It would seem wiser in the long run, even in a text-book, to admit the incompleteness of theory in this direction, rather than risk giving the reader the impression that the solution of all his problems has been achieved. The author's contributions to the development of 'normal' theory will stand by themselves, both for their direct practical value and as an important preliminary to the wider extension of theory, without any suggestion of undue completeness.

A last chapter on the principles of statistical estimation has been added to this edition. It provides a good illustration of the application of the ideas contained in the introduction and elsewhere, although perhaps it may prove stiff reading for the biologist.

Our Bookshelf.

The Works of Aristotle. Translated into English under the Editorship of Dr. W. D. Ross. Vol. 1: *Categoriæ and De Interpretatione*, by E. M. Edghill; *Analytica Priora*, by A. J. Jenkinson; *Analytica Posteriora*, by G. R. G. Mure; *Topica and De Sophisticis Elenchis*, by W. A. Pickard-Cambridge. Pp. iv + 652. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 15*s*. net.

THIS substantial volume is the first of a series to be added to the well-known Oxford translations, which is to include the whole of the extant works of Aristotle. The six treatises of which this book consists constitute Aristotle's immense contribution to what became known later as the science of logic. The translation faithfully reflects the nature of that contribution.

One might gather from the statements made in many a compendium of the history of philosophy that Aristotle worked out a systematic treatment of logical science. This is not the case. All the same, he was the real founder of logic as a distinctive discipline, and it was he who made the wonderful discovery of the nature of syllogistic inference. His work is set forth in this translation in a manner which will not only satisfy the scholar, but will also make it accessible to educated readers who cannot pretend to be scholars. The four contributors to the volume have worked under the general editorship of Dr. W. D. Ross, whose guidance and inspiration each of them in turn gratefully acknowledges.

The Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1929. Edited by Dr. M. Epstein. Sixty-sixth Annual Publication. Revised after Official Returns. Pp. xxxii + 1448. (London: Macmillan and Co., Ltd., 1929.) 20*s*. net.

THIS valuable year-book has again undergone a thorough revision and incorporates the latest official statistics up to the time of going to press. The lists of books of reference have also been revised. Notable events have occurred in many States during the year, such as the establishment of a central government with new capital in China, the transformation of Albania from a republic to a monarchy, and the restoration of the temporal sovereignty of the Pope. These and other events are duly noted, but the list of separate States now remains the same, and there have been few territorial readjustments during the year. The introductory tables include several of world production of selected commodities. In one respect the value of the book could be enhanced: that is, by the inclusion year by year of more tables of this kind. There is the usual section on the League of Nations. The coloured maps show the City of the Vatican (on a large scale) and the Peru-Colombia boundary adjustment. The size of the book has been slightly reduced, mainly by the condensation of the index, which does not, however, impair its value.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1928. Edited by Dr. M. Epstein. Pp. xiv + 316 + 166. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1929.) 30*s*. net.

THIS well-known work of reference has now reached its hundred and seventieth volume, a length of life which alone expresses its value. It continues on the lines of previous issues. The first part, consisting of about 300 pages, is a survey of the history of the world during the year. As usual, this survey is conspicuous for its completeness and lucidity. Nothing of importance seems to be omitted. In the second part of the book there are a chronicle of events which do not fall within the scope of the historical survey, and obituary of some hundred or more eminent men of all nations. The retrospect of achievements during the year devotes nine pages to a record of science, which is little enough compared with literature and finance, but the scientific chapter is nevertheless an excellent survey of the year's progress. The public documents given in full this year are the Kellogg Pact, the Convention of the Pan-American Union, the Agreement with Transjordania, and the Anglo-Chinese Treaty.

Letters to the Editor.

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

New Evidence of the Action of Sunlight on Aurora Rays.

ON Mar. 15 last I received information from the State Telegraphic Department that earth currents were disturbing the telegraphic service. Believing that we should have an aurora in the evening, I warned my four photographic stations, Oslo, Kongsberg, Tömte, and Oscarsborg, to be ready for action immediately after sunset. Using the excellent type of direct vision spectroscope described by Lord Rayleigh,[1] I was able to localise an aurora arc in the northern sky during the twilight, long before it was possible to distinguish it visually.

The photographic work began as soon as the sky had become dark enough, and a long series of photograms were taken simultaneously from two, three, or four stations during the whole night; among these are 14 quite successful ones from two stations, 38 from three stations, and 12 from four stations. I led the work from my station Oslo, but was obliged to go home about midnight G.M.T. Before going away I asked my excellent collaborators, Wesöe and Tveter, to continue until the dawn and keep a good look-out for sunlit aurora rays, which might probably appear in the late hours of the night. Their perseverance was richly rewarded. At 2 h. 40 m. G.M.T., three hours before sunrise, there suddenly appeared in the north-east long bluish pale aurora rays which developed

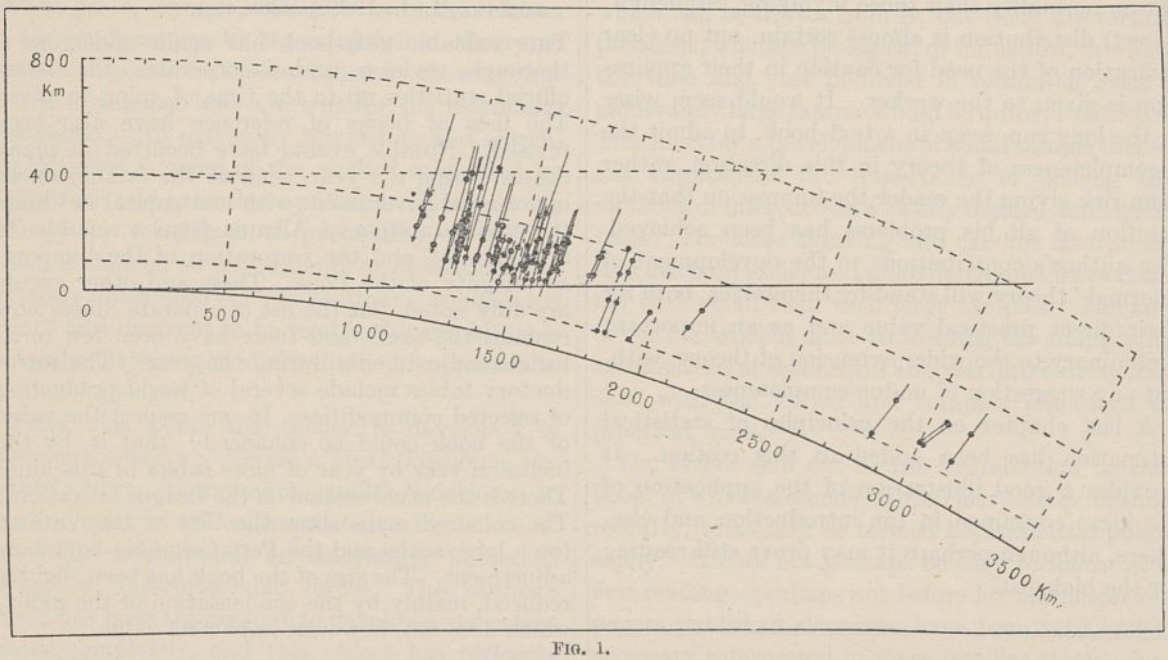
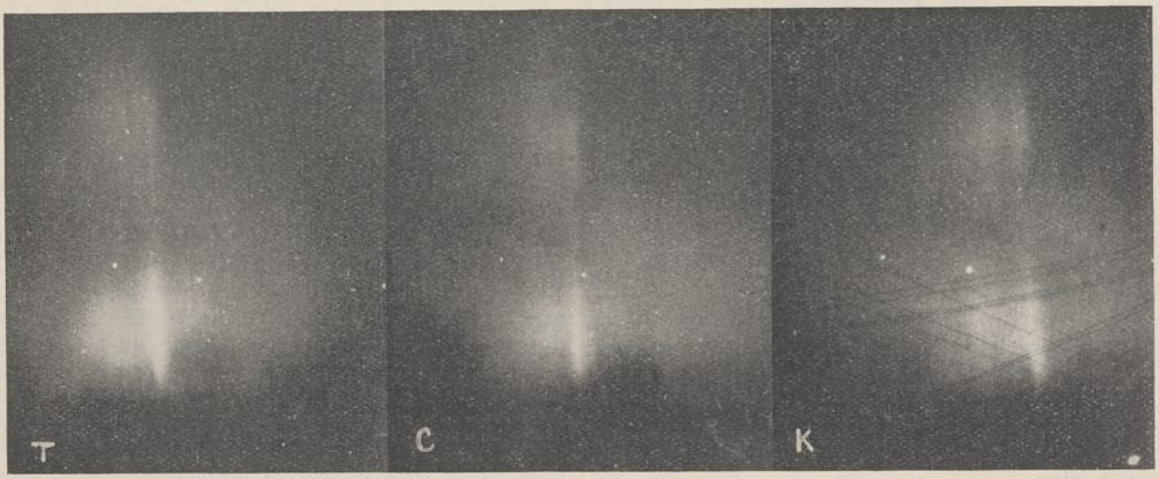


FIG. 1.



TÖMTE. OSLO. KONGSBERG.

FIG. 2.—Photographs of aurora taken simultaneously at the places indicated under them.

[1] "On Visual Observations of the Aurora Line in the Spectrum of the Sky at Night", *Gerlands Beiträge zur Geophysik*, vol. 19, pp. 292-297.

westwards and continued until 3 h. 30 m. G.M.T. Meanwhile, at the station Oscarsborg, where Hafnor was working, the sky had become overcast, but the other three stations were now taking simultaneous photographs as fast as possible one after another, and a large number of successful photograms were secured. At Oslo the photographs were taken by Tveter; at Kongsberg by Busengdal junior; and at Tömte by the Antarctic explorer Carsten Borchgrevink.

The measurement and calculation of those sunlit aurora rays have been made by my assistant Wesöe and myself, and their position relatively to the earth's shadow calculated. Also the other not-sunlit aurora rays of the same night have been treated in the same manner.

On the accompanying diagram (Fig. 1) is seen the position of all the rays of the night of Mar. 15–16 compared with the position of the earth's shadow. The figure represents a vertical section of the earth, and the tangent to the earth's surface is the boundary between the sunlit and dark atmosphere. For each point of an aurora ray the position in the vertical plane through the centre of the earth and the sun is marked by a small circle. On each aurora ray two points are calculated and combined with a straight line representing the ray. This line is continued beyond the points as far as the photographs indicate. If the ray passes out of the photographic field it is marked by an arrow, and if the foot or summit can be seen on the photograph no arrow is given.

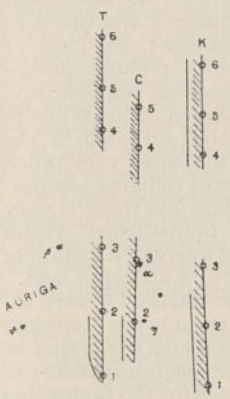


FIG. 3.—The rays as seen from Kongsberg, Oslo, and Tömte are marked by the letters K, C, and T. Corresponding points have the same number.

The high rays were all lying in sunshine, and their lowest points, which have been measured with great care, are situated near the boundary between sunlit and dark atmosphere. Some of the rays have their summits nearly 700 kilometres above the earth, and all lie far to the north, some even in the zenith of Tromsö and northern Finland. The measurements are particularly trustworthy on account of the long base-lines, 46·68 km. from Oslo to Tömte, 65·70 km. from Oslo to Kongsberg, and 105·14 km. from Kongsberg to Tömte. The results have further been controlled by calculating the height in choosing either Oslo—Tömte, Oslo—Kongsberg, or Kongsberg—Tömte as base-lines.

In contrast to these high rays, lower rays are seen to the right on the same diagram; they lie in the dark part of the atmosphere. Thus some of the same general features are seen here as on the diagram published in my communication to NATURE of Jan. 19, 1929. A new and extremely interesting phenomenon was, however, observed with certainty on that night for the first time. Some of the rays consisted of two luminous parts, one situated in sunlight and another in darkness and connected by an invisible part, stretching from the boundary of the sunlight and downwards. These rays are indicated on Fig. 1, the invisible part being dotted. On Fig. 2 are seen the photographs of the rays at 3 h. 16 m. 29s. G.M.T.

The constellation Auriga with the star Capella are clearly seen on the photographs. A sketch of the situations of the principal ray is seen on Fig. 3. On the right border we have chosen the corresponding points 1, 2, 3, 4, 5, 6, and with the different base-lines the following heights were found in km.:

Base-line.	Point 1.	Point 2.	Point 3.	Point 4.	Point 5.	Point 6.
Oslo-Tömte . .		161	202	314	363	
Oslo-Kongsberg .		151	211	323	368	
Kongsberg-Tömte	100	157	214	316	361	409

The lowest point of the upper part was found to be at about 296 km. and the highest point of the lower part to be at about 223 km. above the earth's surface; calculating the height of the boundary between sunlit and dark atmosphere at the situation of the ray, we found it to be 275 km.

Thus the bundle of corpuscular rays causing the aurora ray at first illuminates the upper sunlit atmosphere; then the illumination ceases at the beginning of the dark atmosphere but begins again lower down, when the density of the air is great enough to excite luminosity. The action of sunlight may be a direct one, as mentioned in my former note, or an indirect one in forming a tail which becomes luminous where it is penetrated by the bundle of corpuscular rays.

CARL STÖRMER.

Oslo.

A Property of Superconducting Metals.

IN a recent article by Kapitza (*Proc. Roy. Soc.*, A, **123**, 342; 1929) it is suggested that (1) superconductivity is a general phenomenon, which can exist in all metals, but (2) is "masked by an additional resistance which does not disappear in most metals at low temperatures". This additional resistance is supposed to be due to "structural and chemical imperfections of the metal". Regarding (1), it appears that the superconductors have a peculiar hitherto unnoticed property, which will be presented in more detail below. Because of this, I am inclined to believe that (1) is incorrect (to all practical purposes), and that one could with equal right say that ferromagnetism is capable of existing in all metals, but is masked by other effects in some. As to (2), it would seem that, since the conductivity in the superconducting state is of an entirely different order of magnitude from that of the conductivity of any normal metal, the additional resistance disappears owing to the short-circuiting, by the pure superconductor, of the impurity or structural imperfection. In the system non-superconductor + impurity, the two resistances are not of such greatly different orders of magnitude, and so the impurity may have a quite marked effect on the resistance.

If one plots relative resistance against temperature, for the various metals (excluding bismuth), with the aid of the tables given by Onnes and Tuyn (*Comm.*, Leyden, Supp. No. 58), then the curve is as follows: (1) At low T, for non-superconductors, approximately horizontal, with a finite intercept on the resistance axis, (2) at higher T, convex toward the temperature axis, and (3) at still higher T, linear in T over a large range of temperature. In an analogous fashion to Kapitza's, one can extrapolate the two linear parts (1) and (3) to intersection, and obtain a 'critical temperature'. When one plots this critical temperature against atomic number, the curve resembles somewhat that of the plot of the Debye characteristic temperature Θ against atomic number, although the connexion, if any, subsisting between these two temperatures is by no means obvious. The striking fact that is observed is that in the case of superconductors, including the newly discovered ones, tantalum and thorium, the critical temperature lies quite low, and probably lower than in the case of non-superconductors. That is, the temperature coefficient of

relative resistance for part (3) of the curve is more nearly $\frac{1}{273}$ for the superconductors than for the other metals. For the same part of the curve, at any given temperature, that metal is most likely to become a superconductor which has the greatest relative resistance. One cannot say that every superconductor has a low characteristic temperature, that of tantalum being at 243° *K.* (F. Simon, *Zeits. f. Phys. Chem.*, **129**, 334; 1927). No superconductor as yet discovered has, however, a high critical temperature, and this fact seems to be more than a chance coincidence.

A superconductivity model which gives a qualitative picture of most of the facts is easily set up. One may think of a crystal as composed of two systems interacting with each other, namely, (1) the lattice with its characteristic vibrations and (2) the electron system, considering the lattice ions at rest. In case (2), which includes electronic interaction, one may, theoretically, solve a Schrödinger equation and obtain eigenvalues and eigenfunctions. The system (1) may then be considered as a perturbation acting on (2). One can assume that, in the superconducting state, the lattice has not sufficient energy to impart it in the form of kinetic energy to the electrons, but that the latter may only change their magnetic energy. Probably, also, there is no net exchange of momentum between electrons and lattice. There subsist, then, no inelastic collisions and no elastic collisions with loss of momentum, so that no resistance can enter.

As to the influence of the magnetic field and its parallelism with that of the temperature, one can be guided by the Heisenberg picture of ferromagnetism. At $T=0$, in a vanishingly weak external magnetic field, the elementary magnets (electron spins) all point in the same direction. If energy is imparted to the system, either because of an external field being applied, or the temperature being increased, then some spins will now be 'antiparallel'. It is assumed that the first excited kinetic energy level lies quite high for the superconductors, so that the magnetic energy cannot be converted into kinetic energy. This marks the essential difference between superconductivity and ferromagnetism, as in the latter case the kinetic energy levels lie so close together (probably) that magnetic energy may be converted readily into kinetic energy and the system will come to equilibrium when as many spins as possible are parallel (consistent with the temperature agitation), while in the former case such a balancing between spins and temperature agitation is not possible.

This picture is advanced only tentatively, to account for the sharpness of the transition temperature and the parallel effects of magnetic field and temperature. Whether it is right or not will only be known when it becomes possible to correlate, at least qualitatively, the value of the transition temperature with other properties of the metal, and to explain the connexion of superconductivity with the character of the resistance curve. JAMES H. BARTLETT, jun.

Zurich, April 27.

MR. BARTLETT brings up in his letter a very interesting view to explain the disappearance of the residual resistance at the threshold temperature in supraconductors. As this residual resistance is produced by impurities or structural imperfections, it is suggested that it can be short-circuited by the perfect (healthy) paths of the conducting metal, which suddenly acquire an abnormally high conductivity of quite a different order from that observed in ordinary metals.

This picture, however attractive it is at first glance, presents some difficulty on comparison with experimental data. If we take, for example, the measurement by Meissner of the resistance (*Phys. Zeit.*, p. 725; 1926) of very good crystals of gold, cadmium, and zinc, in which the residual resistance is many times smaller than in ordinary wires, this makes it possible to estimate the value of the ideal resistance at a low temperature more accurately, and it appears that at 4·2° *K.* the ideal resistance cannot be of a greater order than 10^{-6} of that observed at 273° *K.*, and if we extrapolate the ideal resistance to 1·3° *K.*, we find it to be less than 10^{-7} or 10^{-8}. Only the upper limit can be fixed from present experiments, and the actual ideal resistance may be any number of times smaller. This order for the upper limit of resistance corresponds to that fixed by present measurements for all supraconductors (except lead, where it was proved to be less than 10^{-12}). Thus there is no experimental evidence "that the supraconductive resistance is of any entirely different order" from the ideal resistance of a metal at a correspondingly low temperature.

According to Mr. Bartlett's view, this low ideal resistance of the healthy spot of the crystal must short-circuit the bad spots which contribute the additional resistance even for non-supraconductors, and this does not agree with experimental evidence; for most of the metals the additional resistance remains practically constant in the range of the lowest temperature. On the other hand, McLellan, Niven, and Wilhelm (*Phil. Mag.*, p. 678; 1928) find that although 2 per cent of cadmium added to lead increases very much the residual resistance, the lead still remains a supraconductor. In this case it seems to me there is very little room left for the healthy undisturbed crystal lattice, as in a line of atoms, on an average a cadmium atom will be separated by only 3 or 4 atoms of lead.

The sketch of the theory of Mr. Bartlett is very interesting, and it will be most important to see it worked out and tested by experiment. It seems to me that at present the greatest difficulty which meets any theory of supraconductivity is to account, not for the high value of the conductivity, but for the suddenness of the phenomenon. This is especially difficult, since the experiments definitely indicate that no structural or thermal phenomenon occurs at the threshold temperature, and I fail to see how Mr. Bartlett accounts in his theory for the suddenness of the appearance of supraconductivity. In any event it is evident that, according to his views, the mechanism of supraconductivity must take place in the healthy paths of the metal, and we must expect that the threshold temperature will be independent of the kind of impurity and a constant for any given supraconductor. This does not seem to be strictly the case; for example, in indium in different specimens the threshold temperature was found to be different (Tuyn and Kamerlingh Onnes, *Com.*, Leyden, No. 167*a*, p. 6).

On my view, which was supported by the evidence obtained in experiments on change of resistance in magnetic fields, the phenomenon of supraconductivity is accounted for by the sudden disappearance of the disturbances produced by imperfections in the metal which are the reason for the additional resistance. The advantage of this view is, first, that as the change must take place only in local spots in the metal, no change in the general state of the metal will be required as actually observed (possibly, if the impurities amount to several per cent, such a change may be experimentally traced). Secondly, we should expect that the threshold temperature would vary with different impurities introduced in the metal. It is evident that on this suggestion it is practically inevitable that all metals at low temperatures will become supraconductors, if the influence of the impurity can be eliminated. I do

not think that there is any experimental evidence that the supraconducting metals form a separate group of elements like the ferromagnetic group or are exceptional in some other ways. We find the supraconducting metals in four groups of the periodic table. They have either a cubic or most irregular lattice, some of them belong to the transition group of elements, and we have amongst them the metals of the highest and lowest melting point. All the special relations between resistance and temperature for supraconductors pointed out by Mr. Bartlett are found by a more minute analysis of experimental data to apply also to some non-supraconductors. The special significance which Mr. Bartlett attaches without any theoretical justification to the fact that all supraconductors have a characteristic temperature below 243° *K.*, probably is no more significant than the fact that the atomic weight of every supraconductor is higher than the 115 of indium, because this happens to be the lightest supraconductor.

Finally, the very important recent discovery made by de Haas (NATURE, Jan. 26, p. 130) that the eutectic alloy of gold and bismuth can become a supraconductor, must be considered very carefully. The details of the experiment are not yet known, but from the point of view which I am defending, the explanation of the phenomenon may be that in a mixture of gold and bismuth one of the metals absorbs more readily the impurities of the other, and this purification may be of such a nature that it allows one of the components to become a supraconductor.

All these considerations, no doubt, cannot be regarded as final proof of my suggestion, but they offer a definite application of the hypothesis and give a quite fresh experimental line of attacking the problem of supraconductivity.

P. KAPITZA.

The Cavendish Laboratory
(Magnetic Laboratory),
Cambridge.

Mass and Size of Protein Molecules.

BY means of a method which utilises the measurement of sedimentation equilibrium and sedimentation velocity in strong centrifugal fields at constant temperature, a systematic study of the mass and size properties of the molecules of various proteins has been carried out in this laboratory during the last five years. Our work has been rewarded by the discovery of a most unexpected and striking general relationship between the mass of the molecules of different proteins and the mass of the molecules of the same protein at different acidities, as well as of a relationship concerning the size and shape of the protein molecules.

It has been found that all stable native proteins so far studied can with regard to molecular mass be divided into two large groups: the hæmocyanins with molecular weights of the order of millions and all other proteins with molecular weights from about 35,000 to about 210,000. Of the group of the hæmocyanins only two representatives, the hæmocyanin from the blood of *Helix pomatia* with a spherical molecule of weight 5,000,000 and a radius of 12·0 $\mu\mu$, and the hæmocyanin from the blood of *Limulus polyphemus* with a non-spherical molecule of weight 2,000,000, have been studied so far.

The proteins with molecular weights ranging from about 35,000 to 210,000 can, with regard to molecular weight, be divided into four sub-groups. The molecular mass, size, and shape are about the same for all proteins within such a sub-group. The molecular masses characteristic of the three higher sub-groups are—as a first approximation—derived from the molecular mass of the first sub-group by multiplying by the integers *two*, *three*, and *six*. The molecules of the first and fourth sub-group are spherical, with a radius of 2·2 $\mu\mu$ and 4·0 $\mu\mu$ respectively, while the molecules of the second and third sub-group are non-spherical. Ovalbumin and Bence-Jones's protein belong to the first sub-group; hæmoglobin and serumalbumin belong to the second sub-group; serum globulin belongs to the third sub-group; Rhodophyceæ-phycocyan, Cyanophyceæ-phycocyan, Rhodophyceæ-phycoerythrin, edestin, excelsin, amandin belong to the fourth sub-group in the neighbourhood of their isoelectric points.

The molecules of most of the proteins of the fourth sub-group are easily disaggregated with increasing *p*H. Thus R-phycocyan at a *p*H of 4·6 belongs to the fourth sub-group, but at a *p*H of 6·8 belongs to the third sub-group, that is, its molecules are disaggregated into halves and have lost their spherical symmetry. C-phycocyan at a *p*H of 4·6 belongs to the fourth sub-group, but at a *p*H of 6·8 about one-third of its molecules are disaggregated into halves, at the same time losing their spherical symmetry; at a *p*H of 12·0 the molecules of this protein are probably all reduced to the mass and shape of the protein molecules of the first sub-group, thus regaining their spherical symmetry. R-phycoerythrin at a *p*H of 4·6 belongs to the fourth sub-group, but at a *p*H of 11·0 about one-fourth of its molecules are reduced to the first sub-group. Edestin belongs to the fourth sub-group from its isoelectric point *p*H 5·5 to about *p*H 10. At a *p*H of 11·3 a considerable amount of molecules belonging to the second and third sub-group are present, together with the normal molecules belonging to the fourth sub-group.

Although not more than 11 different proteins belonging to the group which displays these regularities have as yet been studied, it would seem very improbable that the relationship between the molecular masses and sizes were incidental. Perhaps the most striking proof of the close relations between the different proteins is the fact that one and the same protein may, according to the *p*H to which it is brought, appear with the molecular mass, size, and shape of another protein.

When looking for an explanation of these unexpected regularities, it would be well to bear in mind the fact already brought out by many bio-chemical experiences, namely, that Nature in the production of organic substance within the living cell seems to work only along a very limited number of main lines. The great variety appears in the specialisation of details. Thus it would seem that the numerous proteins are all built up according to some general plan which secures for them only a very limited number of different molecular masses and sizes when present in aqueous solution. By varying the constituents of the different proteins (different percentage of different amino-acids, etc.) the chemical and electro-chemical properties may be varied sufficiently to enable the cells to make use of them for their different purposes.

The experimental data upon which the above conclusions are based have to a large extent been published in the *Journal of the American Chemical Society*. Part of the material is unpublished. The investigations have been carried out in co-operation with R. Fåhraeus, J. B. Nichols, N. B. Lewis, E. Chirnoaga, F. Heyroth, B. Sjögren, T. Katsurai, A. J. Stamm.

THE. SVEDBERG.

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Rate of Decay of Polonium in Different Points of the U.S.S.R.

THE half-period of a radioactive element characterises the rapidity with which it decays. If the classical theory of the spontaneously exploding atom be accepted, this rate should be the same at any point of the earth's surface.

In order to verify this assumption, measurements of the half-period of polonium have been made during the past two years. Polonium was chosen for this purpose, as the most convenient radioactive substance for observations of this kind, because it is easily obtained in a pure state, its half-period can be directly observed ($136{\cdot}5 \pm 0{\cdot}3$ days), and it is also the last radioactive member of the uranium series.

In these experiments polonium was deposited electrolytically on accurately polished gilt brass discs of 75 mm. diameter to avoid the possibility of the oxidation of metallic surface. Discs having small rims were supplied with round covers which safely protected the active layer from mechanical effects. The process of carrying out the experiments was as follows: The discs were carefully measured by means of a compensating electrometric set which allowed their activity to be determined through the magnitude of the ionisation current with an accuracy of 0·2 per cent. The set itself was verified by means of a uranium standard. Just after this measurement the active discs were packed, sealed up and sent by post to a number of places, where they were kept according to instructions in the Local Weights and Measures Offices, which are under the management of the Central Chamber of Weights and Measures.

After an interval of about five months, packets containing the discs were returned to Leningrad and were immediately measured for the second time. The half-period was calculated according to the formula expressing the rate of decay: $I_t = I_0 e^{-\lambda t}$, and to the equation $T = \log 0{\cdot}5 \times I/\lambda$ where I_0 is the initial activity before sending to the points; I_t, the activity after the receipt in Leningrad; t, the time between two measurements; λ, the radioactive constant; and e the base of natural logarithms.

The determinations of the half-periods were made at eighteen points corresponding to eighteen towns, namely, Murmansk (1), Archangelsk (2), Leningrad (3), Vologda (4), Kazan (5), Moscow (6), Samara (7), Kursk (8), Saratov (9), Charkow (10), Rostow/Don (11), Odessa (12), Astrachan (13), Krasnodar (14), Wladikaukas (15), Tiflis (16), Baku (17), Erivan (18).

The most northern point was Murmansk (68° 59′ N.) and the most southern one was Erivan in Caucasus (40° 11′ N.).

All the points were distributed through a distance of 3000 km. along the meridian. The results obtained show that the rate of decay of polonium is far from being equal in all points. The value of the period changed from 125·6 days (Tiflis) to 181·6 days (Krasnodar). A significant reduction for Astrachan gave the value 127·8 days. The average least square error of the observations did not surpass 0·7 per cent.

From the results obtained we reach the conclusion that, taking into consideration the absence of influence of the metal, which could only reduce the value of the half-period, local conditions had an influence upon the rapidity of radioactive decay.

To verify our assumption, the determinations of the half-period were repeated for all eighteen discs after they had lain about five months in Leningrad. The values of the period thus found varied from 137·2 to 139·5 days, which is not outside the limits of observation errors. On the accompanying diagram (Fig. 1) curve A shows the values of the half-period in different places, and curve B the values of the half-period in Leningrad.

The experiments described are preliminary only, and the investigation will be undertaken on a larger scale with the view of determining without any doubt the influence of local conditions upon the rate of decay of radioactive elements.

This phenomenon can be easily explained, if we admit Perrin's theory assumption of the existence of an external source of radiant energy which produces the radioactive decay of atoms. If we admit the existence of this source in the centre of the earth,

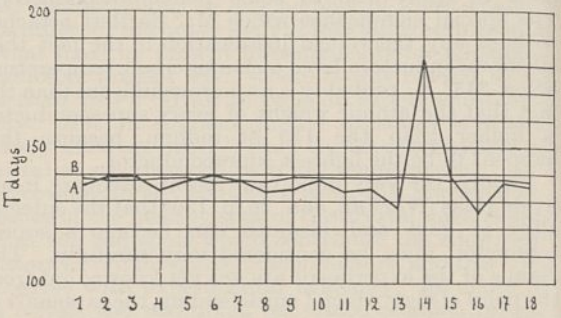

FIG. 1.

the rapidity of the decay must be influenced by the quantity of radioactive substance which is included in the great bulk of the basic rock. The greater the quantity, the less must be the decay in this place because of the absorption of radiant energy, causing the radioactive decay of heavy atoms, by radioactive elements in the underlying layers.

In favour of this assumption also, we have the fact that the greatest deviations of the period occur in places with disturbed tectonics, that is, in the places situated in Caucasus and the region adjoining it, on its northern boundary.

L. N. BOGOJAVLENSKY.
Central Chamber of Weights and Measures,
Leningrad, April 18.

Thyroid and Temperature in Cold-blooded Vertebrates.

THIS problem which Prof. Huxley discusses in NATURE of May 11, p. 712, is a very intriguing one. To me it appears to have more difficulties than Prof. Huxley allows for. He begins by saying that "it is well known that the thyroid is concerned with temperature regulation in homothermic animals". In my recently published book, "Fever, Heat Regulation, Climate, and the Thyroid Adrenal Apparatus", I have reviewed the very scanty and contradictory literature on this subject, and one could scarcely say that the relationship of the thyroid gland to heat regulation has been previously either well known or well understood. I dare scarcely hope that my own views on the problem as set forth in a book published only a year ago have already been assimilated so completely as to have become a commonplace of scientific literature.

In the book mentioned I directed attention to the difficulties of the problem discussed by Prof. Huxley. In warm-blooded animals a change of the thermal environment from heat to cold stimulates the thyroid and adrenal glands to increased activity, and there is a rise in general metabolism. Exposure to heat produces the opposite effect: it induces a resting condition in the thyroid and adrenal glands and the metabolism is lowered. The resting condition of the

thyroid gland is indicated *inter alia* by an accumulation of colloid in the thyroid vesicles. Now in cold-blooded animals exposure to cold produces a fall both in the temperature of the tissues of the animal and in the metabolism, while heat raises both. One might expect that a fall in the temperature of the animal as a whole would diminish the activity of its organs, including the thyroid gland. In that case the interesting conclusion would follow that in the course of evolution the response to an environmental stimulus in a specific group of cells has been completely reversed although the cells have not changed their specific character.

Prof. Huxley's suggestion is that the thyroid of cold-blooded animals, like that of warm-blooded animals, is stimulated by cold and inhibited by heat. This would imply that while the temperature of the animal as a whole falls and the activity of its organs diminishes, one particular organ—the thyroid gland—has a greater functional activity at a lower temperature than at a higher temperature. One cannot exclude *a priori* such a possibility because it appears to be paradoxical. But it requires more convincing evidence for its support than Prof. Huxley adduces from his own experiments. The statement attributed to Adler that in tadpoles low temperature caused hypertrophy of the thyroid gland both in growth and functional activity is open to the criticism that in warm-blooded animals increased functional activity does not manifest itself by hypertrophy.

In conclusion, it may be pointed out that the whole problem is further complicated by the fact that in warm-blooded animals the adrenal gland plays a very important part in the heat-regulating mechanism, this gland acting synergically with the thyroid gland. There is a striking parallelism between the development of the heat-regulating mechanism and the evolution of the adrenal gland as expressed in the changing anatomical relationship of the two histogenetically distinct tissues which in the mammals form cortex and medulla. This must be taken into account when differences in the heat-regulating mechanism of cold-blooded animals is being discussed.

W. CRAMER.

Imperial Cancer Research Fund,
8-11 Queen Square, London, W.C.1,
May 13.

Variation of Latitude with the Moon's Position.

IN NATURE of Jan. 26, 1929, p. 127, Prof. H. T. Stetson has described a variation of latitude with the moon's position, and in the *Comptes rendus de l'Académie des Sciences* of July 30, 1928, A. Gougenheim has described a variation of latitude with the

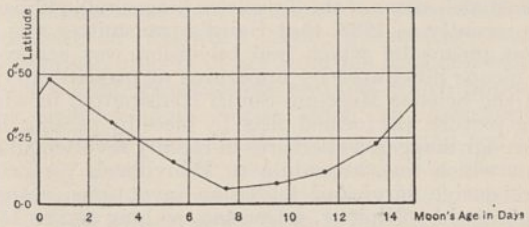

FIG. 1.

age of the moon. In October and November 1926 a series of observations of the latitude of Dehra Dun (India, Lat. 30° N.) were made with a prismatic astrolabe, which show a clear relation between the latitude and the age of the moon (Fig. 1), but no relation at all between latitude and moon's altitude (Fig. 2). The variation with the moon's age was about one-third of that found at Algiers, and was apparently in phase with it.

The fact that the astrolabe at Dehra Dun shows no variation with moon's altitude does not of course

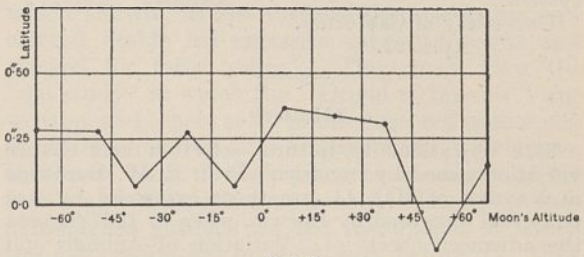

FIG. 2.

invalidate deductions made from Prof. Stetson's more precise and extended series, but it seems surprising that the fortnightly variation (if it truly exists) should be larger and more easily measured than the daily variation.

Each point in Fig. 1 represents about 10 series of observations, each lasting about two hours and giving apparent probable errors of 0".3.

G. BOMFORD.

Survey of India, Dehra Dun.

A New Titanium Band System.

THE dominant feature of the *M*-type stars is the very extensive group of titanium oxide bands, beginning in the blue region of the spectrum and continuing far to the red. The group of bands occurring in the blue-green region has been analysed (see Christy and Birge, NATURE, **122**, 205 ; 1928), and shown to be due to a $^3P - {}^3P$ transition of neutral titanium oxide.

Bands in the red portion have been observed by many investigators and especially by P. W. Merrill, who found that those of the λ7054-λ7700 region are particularly intense in *M*-type spectra. Twenty bands, including in all 46 heads, extending from λ7990 to λ6270, and partially overlapping the above group, have now been assigned to a new system. The lower level is the same as that of the former system in the blue-green. This, and the fact that both systems appear in absorption in stellar spectra, show that the two are resonance systems. The frequencies of the heads of the new system are given by

$$\left.\begin{matrix}14172{\cdot}2\\14105{\cdot}8\\14030{\cdot}8\end{matrix}\right\} + (862{\cdot}5n' - 3{\cdot}84n'^2) - (1003{\cdot}8n'' - 4{\cdot}61n''^2)$$

with an average residual of 1 cm.$^{-1}$. As shown by the formula, the mean separation of the heads is 70·7 cm.$^{-1}$. The mean separation of the lower levels of the blue-green system was shown indirectly to be about 70 cm.$^{-1}$ (see *Phys. Rev.*, May 1929), indicating that the upper level of the new system is single. Each of the three heads of the more intense bands has a clearly marked secondary head at about 10 cm.$^{-1}$ to the red. These latter heads are formed presumably by the *Q* branches. Since transitions between singlets and triplets are very uncommon in band spectra, the upper level is in all probability a ^3S.

The values of ω_0'' and $\omega_0''x''$ (that is, 1003·8 and 4·61) are believed to be somewhat more accurate than those published previously, and are based on the mean separation of levels as found from both systems. Using the new values and assuming a linear extrapolation, the heat of dissociation for the lower level is found to be 6·74 volts. The total energy resulting

from the dissociation at the other two levels is also about 7 volts. There are still a few bands in the region λ6270 to λ5600, overlapping both systems, which remain unassigned. Their general appearance is different from that of the bands in either analysed system.

ANDREW CHRISTY.
University of California,
April 22.

Mimicry.

THE objections to natural selection and chance variation raised by my friend Prof. E. W. MacBride in NATURE of May 11, are those expressed by Asa Gray and answered by Darwin, when in 1867 he sent the advanced sheets of "Variation of Animals and Plants under Domestication" to the great American botanist. The creative power of natural selection is explained by a metaphor:

"If an architect were to rear a noble and commodious edifice, without the use of cut stone, by selecting from the fragments at the base of a precipice wedge-formed stones for his arches, elongated stones for his lintels, and flat stones for his roof, we should admire his skill and regard him as the paramount power. Now, the fragments of stone, though indispensable to the architect, bear to the edifice built by him the same relation which the fluctuating variations of organic beings bear to the varied and admirable structures ultimately acquired by their modified descendants."

Now apply Prof. MacBride's argument to Darwin's metaphor. "Why are certain stones selected? Because they are the fittest." Certainly. "How do we know that they are the fittest? Because they are selected." Obviously absurd.

Again, referring to 'chance' or 'accident', Darwin wrote: "The shape of the fragments of stone at the base of our precipice may be called accidental, but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws. . . . But in regard to the use to which the fragments may be put, their shape may be strictly said to be accidental."

With regard to birds as enemies of butterflies, the necessities of space prevent me from doing more than refer Prof. MacBride to the publications of the Entomological Society of London, where he will find much evidence of serious attacks as well as numerous isolated examples.

In reply to Dr. Carter's interesting letter, I would point out that the behaviour of an insect-eating animal may suggest processes essentially similar to the simpler reactions of man. A chameleon once stung by a honey-bee would never touch another. The association and memory were perfect, after a single lesson. It must be remembered, too, that mimicry is especially characteristic of forest butterflies where the alternation of sunlight and shadow renders the imperfect resemblance of a flying insect far more effective than it would be in uniform light or shade.

EDWARD B. POULTON.
Oxford, May 24.

Another Species of Monœcious Oyster, *Ostrea plicata* Chemnitz.

IT was noted by me in 1926 (*Proc. Roy. Phys. Soc.*, vol. 21, Part 2; 1926) that the different species of *Ostrea* can be grouped into two categories, the monœcious and the dioecious. I also enumerated several fundamental points of difference between them morphologically and physiologically. Later in 1928, J. H. Orton in NATURE, Mar. 3, 1928, put more emphasis upon the distinction of the two categories.

There are more than sixty species of *Ostrea* distributed all over the world. The greater part of them are dioecious, while the recorded species of the monœcious oyster are not many. The first four species given below have already been recorded as having every character of a monœcious species.

I here introduce one more species of the monœcious category which has not yet been recorded as such, namely, *O. plicata* Chemnitz, or *O. plicatula* Gmelin, the latter being probably the synonym of the former. There are therefore five species now known to be monœcious *Ostrea*, as follow:

O. denselamellosa Lischke, the Japanese species.
O. edulis Linn., the European species.
O. lurida Carpenter, the British Columbian species.
O. angasi Sowerby, the Australian species.
O. plicata Chemnitz.

The present species is found on the east coast of Japan. It is by no means very rare, yet it has not attracted much attention of biologists or laymen, as its size is always rather small. The species can attain sexual maturity in one full year, showing 'white-sick' and 'black-sick' stages, as is typical for the monœcious habit. The size at maturity is only three centimetres in the longest diameter. Even the largest specimen rarely attains more than six centimetres.

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Television Inventions.

IN NATURE of April 27, p. 637, a notice appeared of a book by Mr. C. Francis Jenkins, of Dayton, Ohio, entitled "Radiomovies, Radiovision, Television". With some difficulty I have obtained a copy of this book from America, and find in it, in a picture which appears to be on page 74 (though no paging is given), a description copied from a journal of July 25, 1894, ascribing to C. Francis Jenkins an apparatus for transmitting pictures by electricity, under the name of the Jenkins' Phantoscope. This is identical in all essentials with the method of television proposed by G. R. Carey, an American, and dated 1875 according to "La Television Electrique", by A. Dauvillier, published much later, in 1928, by *La Revue Generale de L'Electricite*, of Paris; while an illustrated description of Carey's method also appears in a copy I possess of *Design and Work* for June 25, 1880.

These discrepancies in dates are worthy of notice, as is also the suggestion in "Television", by Alfred Dinsdale (editor of the *Television* magazine), published so recently as 1928, that Baird's transmitter was the first means by which real television was achieved; a means illustrated by apparatus at present on view in the Science Museum, South Kensington, in which the picture was formed piece by piece by passing light through staggered apertures in rapidly revolving discs, but which was, according to Dauvillier's very comprehensive survey of television inventions, actually patented by Nipkow, a German, so long ago as 1884, some forty-two years before the arrangement was attributed to Mr. J. L. Baird, that is to say, actually five years before Mr. Baird appears, from "Who's Who", to have been born.

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40 Chester Square,
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May 28.

Down House and Darwin.

DOWN HOUSE, the home of Darwin from 1842 to 1882, now vested in the British Association in custody for the nation, was formally dedicated to the public access on June 7. A distinguished company of members of the General Committee of the British Association, representatives of Darwin's family and of societies to which he belonged, and other invited guests, listened to the short ceremony at which Sir William Bragg, president of the Association, was in the chair, and Sir Arthur Keith was the principal spokesman.

It will be remembered that Sir Arthur Keith, at the conclusion of his presidential address on the present position of Darwinism, at the Leeds Meeting of the Association in 1927, put forward a plea for the preservation of Down House. This was promptly answered by Mr. Buckston Browne, F.R.C.S., who (in brief) bought the property, gave it to the Association with a generous endowment, has fully restored the whole house, and has brought back the ground floor as nearly as possible to its condition in Darwin's time, presenting many appropriate objects of art from his own collection. Truly a noble benefaction, and one which imposes new and welcome duties upon an Association which should prove itself peculiarly fitted for discharging them. The nearest parallel to them is found in the Association's action in 1842, when it saved Kew Observatory from being diverted from scientific use, and sustained the burden of its maintenance for thirty years. Down House, however, will be no burden, but a very honourable trust.

FIG. 1.—Darwin's house at Down, Kent.

Those whose minds find no appeal in the sentiment underlying the establishment of this memorial to one of the greatest of all leaders of research cannot be otherwise than an insignificant minority. To the many it will mean more than a little to recapture, as they still may, the atmosphere in which Darwin, in the words of the inscription now erected beside his entrance gate, "thought and worked for forty years". They may view the 'old study' in which the "Origin of Species" was written, and others of his rooms, restored with much of his own furniture and articles of use, which have been sent back to their place by members of his family and other generous donors. They may pass through his gardens (in the restoration of which the Association has no small task before it); they may follow him around the Sand Walk and still enjoy, as he did, the view across the pleasant valley towards the Sow Wood, as yet untouched by the builder or any other modernising influence save the gentle intrusion of a golf course; and here is indicated a further justification for the preservation of the property. A pamphlet issued by the Association for distribution to visitors quotes a description of the neighbourhood as "intensely rural and quiet though only sixteen miles from London Bridge", and points out that Down still preserves these characteristics. "It may well be that in the future, as the outer circle of London extends, the preservation" of the estate "will be regarded as an æsthetic blessing only less than as a dutiful tribute" to Darwin's memory.

Behind these considerations, however — one fundamental, the other at least powerful—there arises the hope that the estate may be put to use for the direct benefit of science. The attainment of such an object is present in the minds of the donor, of the members of the Down House Committee which the Association has appointed for the management of the property, and of others besides. No plan has as yet taken definite shape; none could or should be given effect in a moment. But it is not difficult to envisage more than one direction in which this idea—rather, this ideal—could be realised. Meanwhile, when it is realised that the property was only vacated by the previous tenant six months ago, the condition of the property remarkably attests Mr. Buckston Browne's generosity and enthusiasm. A most distinguished American biologist has characterised his action as "initiating one of the most splendid movements of all time". An American committee has been appointed to co-operate with the Association's committee, especially in endeavouring to recover Darwiniana now in America. There are those who look forward to Down as a scientific Stratford-on-Avon for future generations. So may it be.

The British Eclipse Expeditions of May 9, 1929.

By Prof. F. J. M. STRATTON.

BY the time these notes appear in print, the facts on May 9 will be known of the eleven expeditions from France, Germany, Great Britain, Holland, Japan, and the United States which are at present scattered on the line Sumatra—Kedah—Siam—Cambodia—the Philippines. News can only be supplied here of the Japanese expedition under Prof. Sotome to Titra in Kedah, of the German expedition under Dr. Rosenberg to Khoke Bhodi in Siam, and of the two British expeditions to Alor Star in Kedah and to Pattani in Siam. In all cases it can be said that preparations are well in hand, attended so far by no serious delays or troublesome mischances.

FIG. 1.—British observers' camp at Pattani.

Shelters of atap palm, in many cases supplemented by canvas or other linings to get the effect of a double roof, cover the instruments; preliminary adjustments are made and weather conditions do not seem likely unduly to hinder the final adjustments. So far as can be gathered by comparison with present weather conditions, prospects are most favourable at Pattani: their Majesties the King and Queen of Siam are to visit the British camp there for the eclipse, as in 1875 the then King of Siam observed the eclipse from Sir Arthur Schuster's camp.

In Kedah the Resident Adviser to the Regent has done everything to facilitate the work of the expeditions. Dr. and Mrs. Jackson are staying at the Residency and the eclipse camp is close by. The necessary electric current required for Dr. Carroll's comparison arc spectra, and for the mercury lamp to be used by Dr. Aston for the interferometer, has been obtained from the town mains, and through the kindness of the Regent all constructional work required has been done by the P.W.D. Photographic troubles have been largely met by the kind permission of the medical authorities to make use of the dark-room facilities at the local hospital.

In Siam the conditions are much more difficult, but the Siamese authorities have done everything possible to facilitate the work of the observers. At each place the Government has erected a hut camp with mess-room, office, kitchen, six rooms and servants' quarters, lit by electric light. All constructional material required and labour have been supplied, arrangements made to guard the eclipse camps and to meet the requirements of the observers in the matter of electric current by the provision of portable electric plants. His Majesty the King of Siam appointed a special reception committee charged with the duty of helping the astronomers in every way, and right well have they carried out their allotted task. All the local authorities in their turn have added to the obligations that the expeditions are under to the Siamese people. Photographic difficulties are not

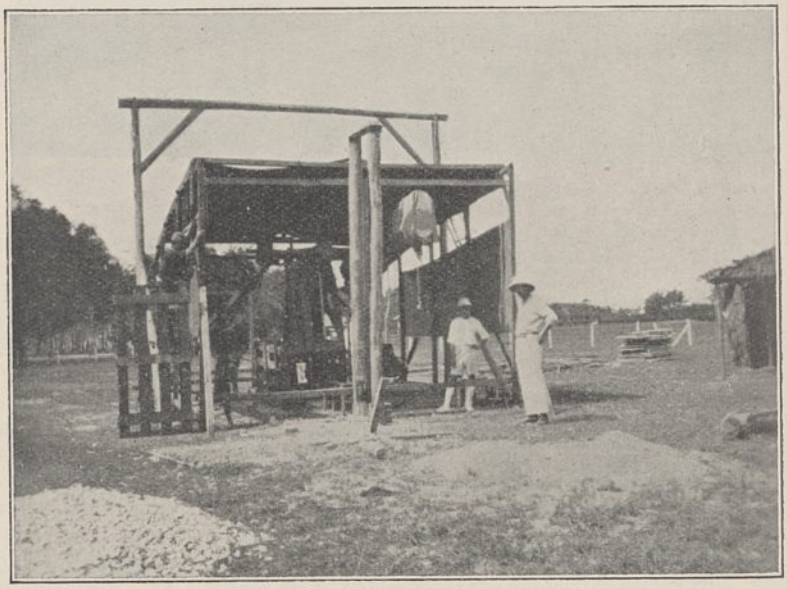

FIG. 2.—Telescope in position at Pattani.

insuperable, though real, in this hot climate. A good deal can be done to meet them with ice from the local factory; and an efficient cooling plant, specially designed to meet the requirements of an eclipse dark room, should make matters still easier by providing a good supply of cooled water.

Most of the personnel for the actual observations have already arrived, but special mention must be made here of the services to the British expeditions of their honorary secretary, Col. J. Waley Cohen. Not only did he thoroughly explore both sides of the peninsula in 1928, bringing back valuable information as to meteorological conditions and as to local possibilities for eclipse preparations—and incidentally he interested many influential people in the coming eclipse—but he also arrived in the East this year ahead of the observers and made all the preparatory arrangements, so that a great deal was already done and in hand when they arrived. At Pattani, Col. Waley Cohen has also continued to relieve the scientists of the expedition of all worries about such matters as messing, local financial arrangements (not easy when there is no bank within many hours' journey of the camp), and the multitudinous details which have to be attended to, if matters are to go smoothly.

The accompanying photographs, taken by Dr. Royds, director of the Kodaikanal Observatory, show (Fig. 1) the special camp erected for the observers to live in, and (Fig. 2) the astrographic telescope from Greenwich in course of erection with Mr. P. J. Melotte's instruments, including a coronagraph of 19 ft. focal length with a direct vision prism for the first and second flash, three spectrographs, and a double tube camera with a Nicol prism in front of one object glass for a polariscopic study of the corona. The party of the observers and assistants on the day of the eclipse will be twelve. In addition to those above mentioned and myself, Prof. E. Barnes and W. F. Kibble, of Madras, have already been at the camp for some days and given valuable help.

Einstein's and other Unitary Field Theories: An Explanation for the General Reader.

By Prof. H. T. H. PIAGGIO.

II.

GEOMETRY ON A SPHERE.

THE leading ideas of the geometry that Einstein chose (Riemannian) can be made clear by considering the properties of a geographical globe (Fig. 1) on which are marked the meridians and parallels of latitude. These divide the surface into what we may call curvilinear rectangles. But these rectangles are not all of the same size or shape. For consider two points with the same latitude but with longitudes differing by one degree. The distance between them depends upon the latitude; it is greatest at the equator and zero at the poles. Thus APB is greater than DQC. For a sphere the distance between two points with the same longitude (*i.e.* on the same meridian), but with latitudes differing by one degree, is constant, but if our globe (like the earth itself) is flattened at the poles, this distance will again depend upon the latitude.

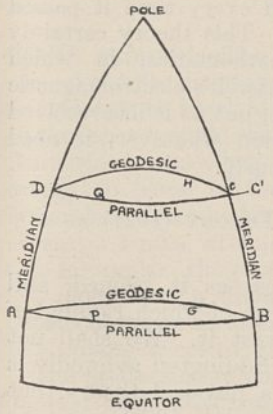

FIG. 1.

In either case, we cannot find the distance between two points A and C on the globe merely by knowing the *differences* of their latitudes and their longitudes, whereas in a plane the distance between two points is determined solely by a knowledge of the differences of their x and of their y co-ordinates. This is what is meant by the rather alarming statement that the sphere has a Riemannian metric, while the plane has a Euclidean one. (In mathematical symbols, $ds^2 = dx^2 + dy^2$ shows a Euclidean metric, but $ds^2 = g_{11}dx^2 + g_{22}dy^2$ shows a Riemannian metric, provided that g_{11} and g_{22} are functions of x and y, or of either of them.)

It is not only a plane that has a Euclidean metric. Take a piece of squared paper, and roll it up, or bend it (without stretching or tearing) into as queer a shape as you please. The squares drawn on it remain all of the same size as before, hence the metric is still Euclidean. Such a surface is said to have zero *Gaussian curvature*, although it is what an ordinary person would call curved. The real distinction between it and a sphere is that the squared paper can be flattened out again, whereas it is impossible to flatten out a sphere or a piece of it (as may be easily verified with a piece of a broken rubber ball). Another way of putting this is to say that any attempt to make a flat map of the earth must be imperfect and give a distorted representation, as is obvious on Mercator's chart near the poles.

A well-known problem in geography or navigation is to determine the shortest route that can be traversed between two points on the earth's surface. On a model globe we can determine this experimentally by stretching a piece of string between these two points. It will be found that it will lie in what is called a *Great Circle*, namely, one the plane of which passes through the centre of the earth. It is important to notice that it is not the same as a parallel of latitude. In fact a ship that has to sail between two points A and B on the same parallel APB (north of the equator) will, to follow the Great Circle AGB, have to sail north of this parallel and then come back to it, a method rather tiresome to navigators, as it entails a continual change of direction (as measured by compass bearing). A Great Circle on a sphere has one of the properties of a straight line in a plane, namely, that of being a *geodesic* or shortest distance between

two points on it, but not (in general) another, that of having a constant direction. This may be considered to belong to a route that makes a constant angle with the meridians; it is called by navigators a *rhumb-line* or *loxodrome*. They often use it, in spite of it not being a geodesic, because it preserves a constant compass bearing, which can be determined at once by drawing a straight line between the two positions, as marked on Mercator's chart. It is important to notice that what we here call constant direction on a sphere is defined by reference to compass bearing, or Pole star, or axis of rotation (through which the meridians pass), each of which is really quite independent of the geometry of the sphere itself, and to that extent is arbitrary.

Geometrical Basis of Einstein's General Theory.

Einstein's General Theory may now be stated broadly as the assumption that the physical geometry of space-time is one which has a Riemannian metric and a curvature, and, in fact, is somewhat analogous to geometry on a sphere. The analogy is made closer if we replace the sphere by a surface like a hen's egg, of which the curvature is variable. If the egg has been hard-boiled and then deprived of its shell, so as to be flexible, the analogy is still further improved, for the Gaussian curvature and Riemannian metric, which depend only on a network of curves drawn on the surface and deformable with it, are the properties with which Einstein is concerned. It is important to notice that no account is taken of any measurements except those made *on* the surface, which from this point of view is a two-dimensional region.

The non-mathematical reader may, however, say, "How can two-dimensional results on a sphere or egg, which everyone can imagine, be applicable to four dimensions, which are inconceivable?" The answer to this is that the symbols used by mathematicians have the valuable property that they enable us to work, largely by analogy, in four dimensions almost as easily as in two. The merit of Riemannian geometry, which to those unfamiliar with it may appear rather complicated, is that in it the physical laws of the motion of a planet or of a ray of light are the simplest possible, namely, that they are geodesics. By stipulating that the paths must be very nearly those given by Newton's law of gravitation, we get some indication of how to determine the coefficients in the Riemannian metric. To determine these fully requires other considerations too lengthy to enter into here.

As is now well known, this theory has been strikingly successful, not only in explaining a known fact, the anomalous motion of the perihelion of the planet Mercury, but also in predicting successfully the effect of a strong gravitational field on the bending of light and the shift of spectral lines. Eclipse expeditions speedily confirmed the first prediction, but the second was originally denied by experimenters. The spectral shift is now admitted to exist, and the minute effects due to the sun have been supplemented by the more easily observed effects due to the dark star of enormous density called the Companion of Sirius.

Physical Basis of the Unitary Field Theories of Weyl, Eddington, and Einstein.

We have seen that the Special Relativity theory is fundamentally an electromagnetic one, while the General Theory is fundamentally gravitational. After constructing a geometry of space-time, specially chosen so as to explain gravitation in a simple manner, Einstein found that electromagnetism could be fitted into the scheme, but could just as well be left out. Now this is scarcely satisfactory. Gravitation and electromagnetism are both physical phenomena, and why should one be considered as an essential property of space, and the other as only an accident? Was the world constructed solely for the requirements of gravitation, and then part of it let off to electromagnetism as a lodger? The obvious thing seemed to be to modify the Riemannian geometry so that it would serve gravitation and electromagnetism equally well.

Geometrical Basis of Weyl's Unitary Theory (1918).

Einstein had made gravitation appear as a natural consequence of replacing Euclidean geometry by Riemannian, in which the geodesics lose their property of preserving a fixed direction. Weyl proposed to replace Riemannian geometry by another, in which the idea of length is also given up. In his theory, at any rate in its original form, the length of a rod altered every time it passed round an electric current! This theory certainly gave some interesting mathematics, in which equations of the form of Maxwell's electromagnetic ones made their appearance, but as it has received no experimental confirmation whatever, it need not be considered very seriously.

Eddington's Unitary Theory (1921) as a 'Graph'.

Weyl's geometry, formless as it seemed, still retained one definite property, of which Eddington promptly proceeded to divest it. We shall not enter into details, because Eddington avowedly is not claiming to construct a physical theory, but only an illustration or 'graph', which may be looked upon as a device useful in enabling us to grasp certain mathematical relations. He hoped it might throw light on the nature of the forces which prevent an electron from exploding, but up to the present it does not seem to have done so.

Eddington considers that not only his own unitary theory, but also Weyl's and Einstein's, are 'graphs'. However, from Einstein's own words—"my opinion is that our space-time continuum has a structure of the kind here outlined"—it would appear that it is claimed to be a genuine physical theory.

EINSTEIN'S UNITARY THEORY (1928–29).

Whereas Weyl and Eddington replaced Riemannian geometry by others still more unlike Euclidean, Einstein has now, in part, returned to more ordinary ideas. His geometry is one which possesses *distant-parallelism* as well as a Riemannian metric. To explain what is meant by distant-parallelism, we return to our two-dimensional analogy. Cover our hen's egg, or any other surface, with a network of 'curvilinear rectangles'. 'Parallel directions' are defined as those which make the same angles with corresponding sides of the local rectangles. This definition leaves the original choice of the network undefined, but we saw that on a sphere direction had to be defined by something, like a magnetic compass or a pole star, which was not a property of the sphere itself, and so in a certain sense undefined by its geometry alone.

Perhaps Einstein's parallel directions may be ultimately defined in terms of dynamics. He may even get back to the position of Newton, who conceived absolute rotation to be a real thing, which could be detected by seeing whether the surface of a fluid was a paraboloid of revolution or a plane. The behaviour of Foucault's pendulum and of gyroscopes certainly seem to furnish us with a dynamical definition of direction.

By using our sphere, we may even give some idea of the actual function that Einstein takes to measure what may be called electromagnetic potential. Suppose a boat has two short trips, each of one mile, one east and the other north. By sailing first one mile east and then one mile north, let us reach a point C. By sailing first north and then east we reach a different point C′, since the parallels of latitude get smaller as we go north (see Fig. 1). The distance CC′ represents Einstein's potential. This illustration is not exact, because on a sphere CC′ is very small compared with the distances AB, BC, whereas in Einstein's theory it is essential that it should not be so. To illustrate this we should have to suppose our sphere to have a crinkly surface.

If we now take the corresponding construction for three dimensions, the result is rather queer. If AB and DC are 'parallel' paths, the path from B 'parallel' to AD will not intersect DC. It is properties of this kind that Eddington finds unattractive, but they are essential to the electromagnetic part of the theory.

Of course the ultimate test of the theory must be by experiment. It may succeed in predicting some interaction between gravitation and electromagnetism which can be confirmed by observation. On the other hand, it may be only a 'graph' and so outside the ken of the ordinary physicist. Einstein's paper points out that so far there has not been time to examine the full consequence of his equations.

Even supposing the theory fully established, there are still fresh worlds for Einstein to conquer. The quantum theory remains outside his scheme. He made an attempt to deal with this so far back as 1923, but without any striking success. However, it has been suggested that the postulate of distant-parallelism will enable the unitary theory to take over Dirac's theory of a spinning electron almost unchanged.

The Detection of Helium.

THE natural facility with which the radioactive elements disintegrate has led on one hand to attempts to break down atoms artificially, and on the other to build them up from simpler particles. Rutherford succeeded in conveying the necessary energy to some of the less massive atoms and broke them down by bombardment with sufficiently energetic α-rays, atom by atom at comparatively rare intervals: the process of atom building is still not more than a dream, realised perhaps in the depths of space as Millikan has suggested in order to account for cosmic rays.

The production of gold from mercury, and many another attempted transmutation, have proved, to put it mildly, apparent rather than real changes. In the case of the experiments in which helium was supposedly formed in some way or another by an electric discharge, there has lurked for a long while a certain feeling of unsatisfactoriness. Prof. Paneth's recent work goes far to dispel this feeling (see *Zeits. f. phys. Chem.*, **134**, 353; 1928; and **1**, 170 and 253; 1928). The outcome is indeed satisfactory: those that found helium have reason to have got it; those that did not might well have found it, and been misled perhaps as to its origin.

Paneth and Peters show that helium is the only gas which at ordinary temperatures can diffuse through glass. At a pressure of 0·5 atmosphere 10^{-11} c.c. of helium will pass through a thickness of 0·5 mm. of soda glass per cm.^{2} per hour. The amount of helium that gets through from the air at ordinary pressure into an evacuated glass vessel (1 mm. wall thickness) is 10^5 times less, so that a glass apparatus is for all practical purposes 'tight' at ordinary temperatures. When warm the rate of diffusion through the glass is much greater (cf. Lo Surdo, *Atti R. Accad. Lincei*, **30**, 1, 85; 1921). A hard glass tube 1·5 mm. thick at 500° C. lets through 10^{-9} c.c. of helium from the air per cm.^{2} per hour. Helium, indeed, can be separated from neon and other gases by diffusion through hot glass. It is otherwise with palladium. Helium will not diffuse through palladium at a red heat. A mixture of helium and hydrogen can be separated completely by diffusion of the hydrogen through a palladium capillary; the quantity of helium that gets through is not even 10^{-12} of the quantity of hydrogen that passes. Helium and neon are found in the gases absorbed by glass which has been in contact with air, but the gas is considerably richer in helium than in neon. On the other hand, if there is a minute flaw in the glass or at a tap, causing a leak however small, the neon and helium found in the residual gases remain in the same proportion as

they exist in the air, approximately 3 : 1. (It is noteworthy that Paneth and Peters found that good taps could be relied on not to leak if properly ground and greased; their apparatus was therefore not made tap-free. Twenty taps standing 48 hours had not leaked to the extent of more than 10^{-6} c.c. air, equivalent to about 10^{-10} c.c. Ne and He.) It can be shown that a vacuum tube which becomes heated by a discharge will contain afterwards traces of helium, if it is not protected from access of air externally, however great other precautions may have been taken to prevent ingress of air. A double wall is not even sufficient if both become warm. It is necessary to immerse the tube in water or in oil which cools and at the same time seals the glass. The presence or absence of helium in the residual gases is therefore mainly a question of the temperature of the walls of the tube and the sensitiveness of the method of detection.

Paneth gives 10^{-12} to 10^{-11} c.c. as the limiting volume of helium which can be detected spectroscopically. This means that in his apparatus the helium and the neon in about 10^{-5} c.c. of air can be detected—a limit about 100 times smaller than that given for the method used by Strutt (*Proc. Roy. Soc.*, A, **89**, 499; 1914). A careful study is made of the quantity of gas required to bring out the various spectral lines for the pure gases neon and helium and their 3 : 1 mixture obtained from atmospheric air. The spectra of the gases are examined using a capillary tube about 0·1 mm. bore; the fine capillary makes it unnecessary to use a slit with the spectroscope. Excitation is provided by external electrodes. The results enabled estimation of very minute quantities of the gases to be made without recourse to uncertain volume measurements in fine capillary tubes. For quantities at the limit of detection (10^{-10} c.c.) only the 5875 and 5015 lines of helium are visible and only the 5852 line of neon. The latter masks the 5875 helium lines in a mixture of the two gases and only 5015 remains visible. Paneth succeeded in this way in measuring the quantities of helium (about 10^{-8} c.c.) generated by only about 40 grams of thorium in 113 days, taking very special precautions to prevent contamination with helium from other sources. Even with every precaution a trace of neon was also detectable.

Either calcium or an electrically heated spiral of palladium were employed for removing large quantities of hydrogen from the gases under examination; for smaller quantities combustion with oxygen at the surface of palladium sponge was used. The gases were taken from place to place along with oxygen which was afterwards removed by absorption with cooled charcoal, the residual rare gases being 'run up' into the capillary tube for the spectroscopic test. Special precautions were taken to prevent any rare gases being present in the electrolytically generated hydrogen and oxygen used throughout the work; these latter were shown to contain less than about a millionth of a per cent of air. All parts of the apparatus with large glass surfaces and those subjected to heat were vacuum jacketted and then immersed in water.

Paneth and Peters have bombarded salts of potassium; they have run a heavy discharge through hydrogen between aluminium electrodes at pressures from 1 to 85 mm. and also between a palladium spiral electrode through which a large quantity of hydrogen was diffused, without obtaining any helium or neon other than traces from ascertained sources. They have tried a powerful silent discharge through hydrogen at 10 to 760 mm. pressure and they have passed a heavy discharge through paraffin, examining the hydrogen so generated. In all cases the results were negative, provided the glass was protected from transfusion by helium from the air. In spite of the stability of helium and the possibility of building it up from protons and electrons with evolution of 7×10^{11} cals per mol, these experiments show that even with a favourable high concentration of hydrogen, the amount of helium so formed is certainly less than 10^{-9} c.c. The same result applies to the production of helium by bombardment of water and of mercury with β and γ rays. To these experiences have to be added those of Allison and Harkins (*J.A.C.S.*, **46**, 814; 1924) in which very heavy discharges were employed, yet with no positive effects. Considering, too, that the sensitiveness of detection in Paneth and Peters' work is claimed to be 10^4 times greater than the volumes of helium and neon obtained in those experiments by other workers which have appeared to give positive results (*e.g.* production of helium from salts of potassium where the quantity found was between 10^{-5} and 10^{-6} c.c.), it is fairly definite that their source must be other than permitted by Paneth's arrangements and precautions.

One of these sources, when helium is alone found, is no doubt the diffusion of helium through heated glass (or quartz). It is interesting to note that this was also the conclusion of Masson in his experiments with the quartz mercury arc (*Proc. Roy. Soc.*, **91**, 30; 1915). It is noteworthy that Paneth found that glass which is exposed to air contains helium and less neon (50 cm.^{2} of glass holds more than 10^{-6} c.c. He). Hydrogen greatly assists the removal of these adsorbed gases. Oxygen, however, has practically no effect in 'washing' them out of the glass. Heating alone without washing with hydrogen is also comparatively ineffective. This fact seems also to explain some features of the earlier work. Prof. Paneth's work has gone a long way to clear up the unsatisfactory state in which this subject had been left. There is now no evidence for the formation of the rare gases by the discharge, but very definite reasons for their detection in the kind of experiments which were carried out (*e.g.* presence of He in X-ray tubes as found by Ramsay (NATURE, **89**, 502; 1912)).

Passing from experimental work of a critical nature to that with a more constructive object, Paneth has utilised his methods of detection of minute quantities of helium in connexion with a variety of other problems (see *Zeit. anorg. Chem.*, **175**, 383; 1928; and *Zeit. f. Elektrochem.*, **34**, 645; 1928). Amongst them may be mentioned the origin of the abnormal helium content of sylvin and beryl,

the quantity and origin of helium in gases of natural origin, and the helium content and age of meteorites. At Ahlen, in Westphalia, a source of natural gas has been found to provide about 40 m.^{3} per day containing 0·19 per cent helium, but this does not compare with the source at Calgary in Canada, 330,000 m.^{3} per day containing 0·33 per cent He, or with that at Petiola in Texas, 425,000 m.^{3} per day of 0·9 per cent. The ages of the various iron meteorites investigated are found to range from that of the Savic meteorite (8000 years perhaps) to the hoariness of the Nelson Co. meteorite, comparable to the age of the earth ($2{\cdot}6 \times 10^9$ years). It is thought that passage near the sun might account for the removal of helium from the Savik meteorite, making it appear more youthful than it is really likely to be.

Another interesting direction of Prof. Paneth's work was in the attempt to prepare helides after the manner in which he has so successfully made hydrides of various elements. No trace of the formation of helides of arsenic, antimony, lead, germanium, selenium, iodine, and chlorine was obtained. In the experiment with chlorine, the merest trace of the formation of a helide would have been detectable. It is considered that such helides as can be formed can only have a very fugitive existence, of the order of 10^{-8} second.

One might recall the words of Leonardo da Vinci in connexion with all this illuminating work: "Experience is never at fault; it is only our judgement that is in error in promising itself such results from experience as are not caused by our experiments". A. C. E.

Obituary.

GEORGE BIRTWISTLE.

GEORGE BIRTWISTLE was born at Burnley in 1877. Educated at Burnley Grammar School and Owens College, he won an open scholarship in mathematics at Pembroke College, Cambridge, in 1895. He was bracketted Senior Wrangler in 1899 and was placed in Class I., Division I., of the post-graduate part of the Mathematical Tripos in the following year. He was immediately elected to a fellowship and was responsible for the mathematical teaching in Pembroke until the time of his death. He had also served as assistant tutor and prætector of the college. He died very suddenly and unexpectedly on May 19.

It was as a teacher rather than as an investigator that Birtwistle was known, and as a teacher that he played a conspicuous part in Cambridge mathematics, especially during the last ten years. In certain respects his position was unique, for he was a link between the older theoretical physics and the new. Since the War, while continuing to lecture on classical mechanics, electrodynamics, and hydrodynamics, his interest in more recent developments, always strong, rapidly increased. He began to lecture on the older quantum theory, on thermodynamics (then just introduced into the schedule of elementary teaching), and finally on modern quantum mechanics. Each of these lecture courses ultimately grew into a book.

As a lecturer, Birtwistle was admirably clear and easy to follow. He set, in fact, a standard of exposition which made it very difficult for anyone to attract students to any duplicate course. His books are like his lectures—admirable expositions of those sections of the subject with which he deals, written in lecture-room style. He seldom attempts to go deeply into difficult points or to present the subject as a single logical whole. His aim is the lecturer's aim—to interest the student in the subject, especially in its more outstanding or exciting parts, and lead him on to other more systematic or abstruse expositions.

In all his lectures and in all three books, Birtwistle was successful in this aim, though naturally in varying degrees. Perhaps the least successful of his books was the last, on modern quantum mechanics. Here, owing to the novelty of the subject and the absence (when Birtwistle wrote) of other more systematic expositions (or indeed of any other exposition), the weakness of his deliberate method becomes more obvious. The book gives rather the impression of a collection of interesting isolated sketches. It stimulates the reader to ask for more, but to what other author is he to turn? With the coming of other books the weakness is already less felt and Birtwistle's book is gaining in value as a stimulating introduction. The staff of the Mathematical Faculty of Cambridge mourn the untimely loss of a valued friend and colleague.

DR. W. MARTIN.

DR. WILLIAM MARTIN, who died on May 24, was known to a very wide circle as an antiquary whose knowledge and insight enabled him to see almost everywhere in London vestiges of the life and activities of former times; but to many others he was known as an authoritative exponent of patent law, and he was an occasional contributor to our columns upon this subject.

Dr. Martin's antiquarian bent led him to treat patent law historically; but he was none the less alive to the conceptions which govern modern practice in this sphere. In his lectures and publications, notably his articles in the *Law Quarterly Review*, he worked out with great originality a systematic key to the immense body of decided cases with which he seemed to be familiar in every part. The law of treasure trove also attracted him; and in it he saw, contrary to the opinions of some antiquaries, means which could be utilised for the advantage of archæology as a check on the surreptitious disappearance into private collections of finds of general interest.

As an antiquary Dr. Martin was insistent on a strict separation of ascertained fact from the accretions of sentiment and fancy which too often obscure instead of illuminating the past. Nowhere was he more impatient of any looseness than in his

treatment of Shaksperiana. He was an acknowledged authority on Shakspeare, and was proud of the part he took as president of the Shakspeare Reading Society in placing in Park Street, near Bankside, the handsome bronze memorial which now marks the site of the 'Globe'.

Dr. Martin was a graceful writer, clear and entertaining as a lecturer, and an ideal guide; with a very practical gift for organising which enabled him to carry through his arrangements strictly to time. Perhaps he found his greatest happiness in conducting parties through almost forgotten alleys and byeways of London which he loved, and filling them from his stores of knowledge with pictures of the life of other days. Many are those who have enjoyed afternoons spent with him on these rambles who will still find pleasure in the remembrance of his easy discourse and the charm of his personality. He was keenly interested in many aspects of natural history, as well as being an authority upon archæological subjects; and he served as president of the South-Eastern Union of Scientific Societies. It was particularly appropriate that Dr. Martin should be elected the first president of the Gilbert White Fellowship, the object of which is "To continue the work of Gilbert White in the study of natural history and antiquities". He took an active part in the meetings and excursions of this Fellowship within a few days of the illness which resulted in his regretted death.

WE regret to announce the following deaths:

Prof. Thomas W. Cave, vice-principal of the South-Eastern Agricultural College, Wye, and for twenty-seven years head of the Veterinary Department of the College, on April 25, aged seventy years.

Mr. A. H. Cheatle, C.B.E., the distinguished aural surgeon, who presented to the Royal College of Surgeons his valuable collection of preparations illustrating the anatomy of the mastoid region, on May 11, aged sixty-two years.

Prof. Peter Gillespie, professor of civil engineering, University of Toronto, at fifty-six years of age.

Commendatore Rodolfo Lanciani, K.C.V.O., Senator of the Kingdom of Italy and formerly professor of Roman topography in the University of Rome, on May 21, aged eighty-three years.

Dr. James Moir, a past president of the Chemical, Metallurgical and Mining Society of South Africa and of the Chemical Section of the South African Association for the Advancement of Science, on Mar. 31.

Mr. O. A. Reade, pharmaceutical chemist, president of the Lowestoft and District Literary and Scientific Association, and author of a flora of the Bermudas, on April 14.

News and Views.

THE King's Birthday honours list includes the names of the following scientific workers and others associated with scientific activities. *Baron:* Sir Edward Allen Brotherton, chemical manufacturer. *Privy Councillor:* Lord Dawson of Penn, Physician-in-Ordinary to the King. *Baronets:* Sir E. F. Buzzard, Physician Extraordinary to the King; Sir Hugh Mallinson Rigby, Sergeant Surgeon to the King. *Knights:* Prof. H. C. H. Carpenter, professor of metallurgy in the Royal School of Mines, Imperial College of Science and Technology; Mr. J. J. Ralph Jackson, Chief Veterinary Officer, Ministry of Agriculture and Fisheries; Mr. W. S. Jarratt, Comptroller-General of the Patent Office; Prof. W. C. MacKenzie, Director, and professor of comparative anatomy, National Museum of Australian Zoology; Dr. Peter Chalmers Mitchell, Secretary of the Zoological Society of London; Prof. C. V. Raman, Palit professor of physics in the University of Calcutta; Brigadier E. A. Tandy, Surveyor-General of India (retired); Dr. R. S. Woods, Honorary Physician and Honorary Surgeon, London Hospital. *K.C.B.:* Sir F. S. Hewett, Surgeon Apothecary to the King. *C.B.:* Major-General H. P. W. Barrow, Director of Hygiene, War Office. *C.S.I.:* Mr. James Herman Field, late Director-General of Observatories, India. *G.C.M.G.:* Sir John Cadman, emeritus professor of mining, University of Birmingham. *C.M.G.:* Dr. L. Cockayne, in respect of honorary scientific services to the Government of the Dominion of New Zealand; Mr. O. F. H. Atkey, Director of the Sudan Medical Service. *G.C.V.O.:* Sir Humphry Rolleston, Physician-in-Ordinary to the King. *C.V.O.:* Dr. L. E. H. Whitby, bacteriologist. *M.V.O.:* Prof. E. C. Dodds, professor of bio-chemistry at Middlesex Hospital. *C.I.S.O.:* Mr. W. A. Baker, lately Surveyor-General, Jamaica; Mr. J. F. Halpin, Superintending Chemist, Government Chemist's Department. *G.B.E.:* Prof. Dame Helen Gwynne-Vaughan, professor of botany in the University of London; Sir Arthur McDougall Duckham, Director-General of Aircraft Production. *K.B.E.:* Major-General T. H. Symons, Honorary Surgeon to the King, Director-General, Indian Medical Service. *C.B.E.:* Mr. P. N. H. Jones, Director of Public Works, Bermuda; Lieut.-Col. F. J. McCall, Director of Veterinary Services, Tanganyika Territory; Capt. R. S. Rattray, for services as Government Anthropologist in the Gold Coast and to aviation in West Africa; Col. A. H. Safford, Assistant Director of Medical Services, Baluchistan District, India; Mr. Nicholas White, Chief Engineer, and Secretary to the Government of the Punjab, Irrigation Branch. *O.B.E.:* Mr. H. Brown, Principal Officer, Plant and Animal Products Department, Imperial Institute; Major D. G. Cheyne, Deputy Assistant Director of Hygiene, China Command; Dr. F. Dixey, Director of the Geological Survey, Nyasaland Protectorate; Major J. N. Duggan, professor of ophthalmic medicine and surgery, Grant Medical College, Bombay; Mr. J. C. F. Fryer, Director, Ministry of Agriculture and Fisheries Pathological Laboratory, Harpenden; Lieut.-Col. F. J. M. Stratton, professor of astrophysics in the University of Cambridge; Mr. G. Stuart, Assistant Director, Laboratories, Department of Health, Palestine. *M.B.E.:* Mr. E. W. Davy, Assistant Director of Agriculture, Nyasaland Protectorate.

THE Lords Commissioners of H.M. Treasury have appointed a committee to inquire into matters affecting the functions and staff of certain Research and Experimental Establishments of Government Departments, with the following terms of reference: To examine the functions and organisation of the undermentioned Establishments in the Government Service and to report on the method of recruitment and conditions of service of the civilian scientific and technical officers employed therein: (*a*) The Research and Experimental Establishments under the Admiralty, War Office, Air Ministry, and Department of Scientific and Industrial Research; (*b*) the Department of the Government Chemist and the Establishments under the Admiralty and War Office concerned with chemical analyses; and (*c*) the Meteorological Office.

THE chairman of the committee is Prof. H. C. H. Carpenter, professor of metallurgy, Royal School of Mines, and the members are Sir W. J. Larke, the director of the National Federation of Iron and Steel Manufacturers; Sir Robert Robertson, government chemist; Mr. F. M. Morris, the assistant secretary at the Treasury in charge of staff questions affecting the Defence Departments; Mr. R. J. G. C. Paterson, one of the directors of finance at the War Office; Dr. F. E. Smith, director of scientific research, Admiralty; Mr. H. T. Tizard, secretary of the Department of Scientific and Industrial Research; and Mr. H. E. Wimperis, director of scientific research, Air Ministry. The secretary is Mr. H. Brittain, a principal at the Treasury.

As was indicated in our leading article of May 11, the impending appointment of an inquiry into the organisation and lay-out of the research and experimental branches of the Civil Service was used in April last by the representatives of the Government on the National Whitley Council for the Civil Service as a reason for refusing a Joint Committee which the Staff Side, at the instance of the Institution of Professional Civil Servants, had proposed. It was understood that the official committee then foreshadowed would cover the whole of the research and experimental activities of government departments and would deal mainly, if not exclusively, with the widest questions of structure and organisation. Under the terms of reference now announced, however, the committee's sphere of action does not include the Museums, the Observatories, or the Research Services of the Ministry of Agriculture and Fisheries, and its authority to deal with matters of high policy is apparently confined to examination. We are also a little mystified by the relationship of this new committee to the Research Co-ordination Sub-Committee of the Committee of Civil Research which was appointed in 1926 under the chairmanship of Mr. W. G. A. Ormsby-Gore, and which presumably is continuing to function, since the report which it issued last year was purely descriptive in character. We understand that the Institution of Professional Civil Servants, which represents the staffs to be considered by the committee of inquiry, has been invited to submit evidence, but has not yet decided its policy.

EDUARD SUESS, the most illustrious member of the great school of geology in Vienna, was born in London on Aug. 30, 1831, and the Geological Society has placed a memorial tablet on the house, 4 Duncan Terrace, Islington. The tablet was unveiled on May 28, by his Excellency the Austrian Minister, Baron G. Frankenstein. The president of the Geological Society, Prof. J. W. Gregory, remarked that Suess came of a family that was settled in South Saxony by 1524. His father was destined for the Church, in which many of his ancestors had served; but he entered the wool business, and lived for a time in London. He removed to Vienna, where Eduard Suess graduated at the University, served on the staff of the Royal Museum, and was appointed professor at the University in 1857. Suess applied his geological knowledge to the provision of a better water supply for Vienna, and thereby effected a great improvement in the health of the city, which became a pioneer in the improvement of municipal water supplies. Suess's world-wide scientific reputation depends on his contributions to geology and physical geography. His views were most fully published in his "Face of the Earth"; they were so original and unorthodox that he was for a while regarded as a visionary, and his writings set aside as 'geo-poesy'.

SUESS'S main principles have been generally accepted and have had a fundamental influence on modern ideas of the internal structure of the earth and its geographical evolution. Before his work it was generally believed that changes in the distribution of the sea and land were due to irregular local oscillations of the crust. Suess held that they were mainly regular and world-wide in range, and due to changes in the form of the earth that cause a general advance of the sea at one time and retreat at another. The origin of mountain chains he attributed to the crust being folded by pressure in one direction forming waves which advance until they are stopped by older rigid masses of land, as waves of the sea are kept back by the projecting forelands along a coast. Suess ranks as the greatest original force in the geological philosophy of his time, as well as being remarkable for his influence as a far-seeing educationist and municipal reformer, statesman, and economist. The Austrian Minister expressed his pleasure at this recognition of the work of the great Viennese geologist. The Rt. Hon. Sir Maurice de Bunsen, on behalf of the Royal Geographical Society, expressed appreciation of Suess's work. Dr. F. A. Bather, representing the Royal Society, referred to the scientific imagination with which Suess handled his material. Alderman Harper, the Mayor of Islington, promised that the local authorities would see to the safety of this memorial to one of the illustrious sons of Islington. Sir Arthur Smith Woodward and Prof. W. J. Sollas, in moving a vote of thanks to the Austrian Minister, referred to Suess's nobility of character and literary distinction.

A PARTICULARLY interesting account is given in the *Engineer* of May 31, of the replica of the famous locomotive *Rocket*, which won the competition at

Rainhill on the Liverpool and Manchester Railway in October 1829, and at the same time established once and for all the suitability of the steam locomotive for railway work. The original *Rocket*, or what remains of it, stands in the Science Museum, South Kensington, but the replica has been made for Mr. Henry Ford for his museum at Detroit. The task of building the new *Rocket* was given to Messrs. Robert Stephenson & Co., Ltd., Darlington, the successors of the old Stephenson firm at Newcastle, and immense pains have been taken to follow as closely as possible the original plans. As is well known, the original *Rocket* was altered very considerably and to-day many parts are missing. The design of the fire-box—one of its most important features—has long been a matter for inquiry and discussion, but apparently the experts are now fairly well agreed as to the details, and in the replica Mr. Ford possesses what is undoubtedly the most complete piece of engine reconstruction ever carried out. Though there are various memorials to George and Robert Stephenson and to Henry Booth, who were jointly responsible for the building of the *Rocket*, on June 8 we shall possess another memorial to George Stephenson, for on that day the Lord Mayor of Newcastle-upon-Tyne will unveil a tablet on the cottage at Wylam, Northumberland, where he was born. The tablet has been erected through the joint efforts of the North-East Coast Institution of Engineers and Shipbuilders and the Institution of Mechanical Engineers.

MR. E. B. FORD, of the Department of Zoology, University of Oxford, delivered a lecture before the Eugenics Society in the rooms of the Royal Society on May 29, on "Recent Work on the Physiology of Genetics and its Bearing on Human Problems". Mr. Ford stated that the physiology of genetics has only been studied in comparatively recent years. Indeed, it could scarcely have been investigated until a considerable body of evidence respecting the mechanism of inheritance had been built up. Such evidence has now been obtained, and has resulted in an accurate knowledge of the behaviour of genetic factors and of the characters for which they are responsible, but the developmental processes by which these characters are produced are still for the most part obscure. Prof. R. Goldschmidt in Germany has, however, thrown some light on this part of the problem. He was led to postulate factors controlling the *rate* of production of sex-differentiating substances in his work on sex-determination, and later in other characters, in moths. However, these are animals which differentiate by means of sudden metamorphoses. For this reason they are unsuitable for an investigation of developmental processes. This difficulty has to some extent been overcome in Great Britain by the study of a Crustacean which grows and develops throughout life. By this means it has been possible to examine in detail a number of factors affecting the rate and time of onset of processes in the body, and their interaction with each other and with the environment. It is probable that factors of this type are of great importance in the mammals. In man they should be of particular interest, since so many of the differences which separate the human species from the apes are qualitative, and depend upon rates of development and the time at which certain processes begin. We have here an indication of how such differences are inherited and controlled.

THE Zoological Society of Scotland has entered upon a new and important stage of its steady development. The large area of ground, formerly a golf-course, which rises to the ridge of Corstorphine Hill, has been taken over, a road has been made traversing the new ground, large grass paddocks have been partitioned off, and a series of enclosures in the live rock has been created for beasts of prey at a cost of some £3500. Great improvements also continue to be made, we learn from the sixteenth Annual Report, in the older part of the Park. Unsightly cages have been replaced by rock-dens, and an extensive monkey-house, designed on modern lines and now in course of erection, promises to be as successful as the recently built houses for tropical birds and reptiles. The application of a device for the circulation and filtration of water has enabled the director-secretary to add a number of salt-water tanks to the Aquarium, much to its gain in attractiveness, and at a cost very much less than that of the original proposal for storage tanks. During the year 86,000 visitors entered the Park, and the accounts show a record surplus on the year of more than £4700.

THE teaching of Nature study in schools has been a problem bristling with difficulties, and to these difficulties is largely due the predominant place in school-teaching taken by the more concrete sciences of chemistry and physics. Part of the trouble is due to the impossibility of finding teachers with the necessary outlook and training, and this, we are inclined to think, may be traced to the tendency of the training colleges to model the biological syllabus too closely upon the botanical and zoological courses in the Universities. That is to say, too much stress has been laid upon the structure and systematics of plants and animals and too little upon life-activities. It is, therefore, with unusual pleasure that we welcome a course of Nature study, which in the hands of an intelligent and sympathetic teacher should bring to the class-room the real feeling of the progression of living things. The course is outlined week by week in *The Schoolmistress*, under the title "In England—Now!" by Mrs. Maribel Edwin, the daughter of Prof. J. Arthur Thomson. The general scheme of the series is to follow natural history the year round in Britain, and this is accomplished by striking in the first week of each month the keynote of the month, and in the succeeding weeks, by analysing the month's activities in greater detail. The treatment exhibits insight and imagination, and the wall diagram, on which pictures of the creatures and plants referred to may be hung in their appropriate environment month by month, strikes a practical note which must appeal to teacher and pupil alike.

THE fifth meeting of the Wool Breeding Council, appointed jointly by the Secretary of State for Scotland and the Minister of Agriculture and Fisheries

to advise the Departments of Agriculture for England and Wales and Scotland on questions relating to the improvement and utilisation of wool grown in Great Britain, was held at the Animal Breeding Research Department, University of Edinburgh, on May 23. Sir Robert Greig, chairman of the Council, presided. Short statements on research work in progress were submitted to the Council. In co-operation with the University College of North Wales, Bangor, large scale breeding experiments have been conducted in order to determine the mode of inheritance of the birth coat of lambs and the relationship between the type of birth coat and kemp in the subsequent fleece. At the Animal Breeding Research Department, University of Edinburgh, the work includes a critical repetition of the grafting experiments carried out by Dr. Voronoff, a study of the rôle of the pituitary gland in producing early maturity, and an investigation into the possibility of securing the moulting of kemp by the use of thyroxin.

DR. E. N. DA C. ANDRADE described "The Air-Pump: Past and Present" in a discourse delivered by him at The Royal Institution on May 31. The obtaining of a vacuum is an essential step in the majority of modern physical experiments, and in many of the products of the modern electrical industry, such as the electric lamp, the thermionic valve, and the X-ray tube. With modern methods a pressure of a ten-thousand-millionth of an atmosphere can be attained, which means only a few hundred million molecules per cubic centimetre. During the past sixteen years new principles of obtaining high vacua have been applied which have proved of the utmost importance for the laboratory and electrical workshop. At very low pressure the free path between the collision which a molecule makes with others is long, and the new pumps do not come into action until this state has been reached, and so work in conjunction with a preliminary pump which reduces the pressure sufficiently. In one type a cylinder provided with special grooves rotates very rapidly, and actually throws the molecules forward as sparks are thrown by a grindstone: this type of pump is usually called a molecular pump, and is very efficient, but demands great care in construction. In another type, which might with equal justice be called a molecular pump, since it is based on a consideration of molecular properties, a jet of vapour entrains the molecules which diffuse into it, and the pump is therefore often called a diffusion pump. The vapour itself has to be condensed, so the pumps are also called condensation pumps. Hitherto mercury vapour has generally been used for these pumps, on account of the non-volatile nature of the liquid at ordinary temperatures, but within the last year oils have been produced which can take its place, and within the last month or two another liquid still has been utilised.

THE first David Ferrier lecture of the Royal Society will be delivered on June 20 by Sir Charles Sherrington, upon the subject of "Some Functional Problems attaching to Convergence."

DR. H. S. H. WARDLAW, of the Department of Physiology of the University of Sydney, has been elected president of the Linnean Society of New South Wales for the current session.

PROF. RAYMOND A. DART, professor of anatomy in the University of the Witwatersrand, Johannesburg, has been elected a corresponding member of the Italian Society of Anthropology, Ethnology, and Comparative Psychology. The society was founded in 1871 and the number of corresponding members is limited to ninety.

FURTHER information is now available with regard to the large earthquake which was recorded at Kew Observatory and other seismological stations on May 26. In a message which was broadcast on May 27, in code, from Arlington, the United States Coast and Geodetic Survey gives the position of the epicentre as in Lat. 56° N., Long. 137° W., that is, under the Pacific Ocean, about 100 miles from Sitka, Alaska. The time was 22 hr. 40 min. G.M.T., which is 14 hr. 40 min. Pacific Coast time.

BY kind permission of the director of the Rothamsted Experimental Station, Harpenden, a summer meeting of the Royal Meteorological Society will be held there on Wednesday afternoon, June 12. Fellows will make a general tour of inspection of the various departments, and will visit the classical field plots and the meteorological station, where a number of recording instruments are maintained.

AT the general meeting of the Imperial Academy of Japan, held on April 12, Sir Alfred Ewing was elected a foreign member. The president, in announcing this election, stated that the Academy most highly appreciated Sir Alfred's numerous and important contributions to science, and gratefully remembered his untiring efforts in promoting in Japan the spirit of studying science for its own sake when scientific study was just beginning to be pursued in that country half a century ago.

THE New York correspondent of the *Times* announces that Prof. Henry Fairfield Osborne, president of the American Museum of Natural History, has secured from the Muller heirs in Sao Paulo, Brazil, the originals of an entire series of letters from Charles Darwin to the great German naturalist, Dr. Fritz Muller, with the view of sending them to be added to the memorial collection at Down House.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A science teacher for day and evening work at the Walker Technical College, Wellington, Shropshire — The Principal, Walker Technical College, Hartshill, Wellington, Shropshire (June 11). A lecturer in engineering at the Wigan and District Mining and Technical College—The Principal, Mining and Technical College, Wigan (June 12). A full-time assistant lecturer in pharmaceutical subjects, and a full-time lecturer in electrical engineering at the Leicester College of Technology — The Registrar, College of Technology, Leicester (June 19). An

adviser in agricultural chemistry in the University of Manchester—The Registrar, The University, Manchester (June 20). A lecturer in physics in the University of Durham (Durham Division)—The Head of the Department of Science, University of Durham, South Road, Durham (June 22). A lecturer in mechanical engineering at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (June 22). An assistant inspector under the Ministry of Agriculture and Fisheries for work in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 24). Two assistant superintendents under the Geological Survey of India—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (June 24). A director of the Bureau of Economic Research of the Commonwealth of Australia—The Official Secretary, Commonwealth of Australia, Australia House, Strand, W.C.2 (July 1). A professor of Indian history and archæology in the University of Madras — The Registrar, University of Madras, Triplicane P.O., Madras (August 19). An instructor in engraving and etching, and an instructor in decorative composition and design in the new Higher School of Fine Arts, Cairo—The Ministry of Education, Cairo (Sept. 30). A chemist under the Air Ministry, Kidbrooke, with up-to-date knowledge of analytical methods, organic and inorganic chemistry, with specialised knowledge of one of the following subjects: (*a*) metallurgy; (*b*) petroleum technology; (*c*) non-metallic aeronautical materials, *i.e.* lubricating oils, dopes, paints, etc.; (*d*) textiles; also a chemist with analytical experience in organic and inorganic work, and, if possible, specialised knowledge of metallurgical chemistry or petroleum technology—The Secretary (I.G.), Air Ministry, W.C.2. A supervisor for the scientific instrument testing department of W. G. Pye and Co.—W. G. Pye and Co., Granta Works, Cambridge. A laboratory steward for the biochemical laboratory of University College, London—The Secretary, University College, Gower Street, W.C.1. A plant physiologist at the Welsh Plant Breeding Station, Aberystwyth — The Secretary, Welsh Plant Breeding Station, Agricultural Buildings, Aberystwyth. A laboratory assistant for the Health Department of the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/1546). A junior assistant at the Experimental Station, Porton—The Chief Superintendent, Chemical Warfare Research Department, War Office, 14 Grosvenor Gardens, S.W.1.

Our Astronomical Column.

MATTER IN INTERSTELLAR SPACE.—The existence of interstellar calcium, as evidenced by the detached [*H*] and [*K*] lines in stellar spectra, has for some time engaged the attention of Dr. O. Struve (see, for example, NATURE, vol. 122, p. 252). His latest researches, made in collaboration with Prof. B. P. Gerasimovič, and described in the *Astrophysical Journal*, vol. 69, p. 7, deal with the physical properties of calcium and other elements in interstellar regions. Eddington's hypothesis of an interstellar substratum embodying the whole galactic system is regarded as the most satisfactory hypothesis at present, and the one most in accordance with both observational data and theoretical considerations. This substratum consists of many elements in various states of ionisation, with an average density of the order of 10^{-26}. The observed intensities of detached Ca^+ lines show a definite distance effect, such as would be expected from a uniform distribution of Ca^+ with a density of about $3{\cdot}6 \times 10^{-32}$. The substratum of interstellar matter appears to share the rotational motion of the stars round a distant central mass in galactic longitude 325°.

THE SUNSPOT CYCLE AND THE CORONA.—It is about half a century since it was first noticed that the form of the corona varies with the progress of the sunspot cycle. Our knowledge on the subject has become more definite from the aid afforded by the long series of coronal photographs that is now available. Recently, studies on the subject have been made by Profs. H. Ludendorff and S. A. Mitchell. The latter contributes an article to *Popular Astronomy* for April, which discusses and amplifies Ludendorff's conclusions. The ellipticity of the corona near the sun's limb is denoted by *a*, that at a distance of one radius from the limb by $a+b$; a varies very little with the sunspot cycle, its mean value being 0·04; b is zero at maximum sunspot activity and about 0·26 near minimum activity; it appears, however, to reach its maximum a year or two before sunspot minimum. Mitchell notes that the coronal spectrum appears also to change its type; thus the line at λ6374 in the red, which is not often observed, was well seen both in 1914 and in 1925, these being at the same phase of the cycle. It is suggested that the Wolf numbers are a better guide to the type of corona than the phase of the sunspot cycle; it is also noted that the corona of 1918 was abnormal; it occurred a year after sunspot maximum, and had most of the features of maximum type, but there were also the strong polar brushes associated with minimum type.

OCCULTATIONS OF STARS BY VENUS.—*Acta Astronomica*, series A, vol. 2, contains a discussion by J. Witkowski of the occultations of three stars by Venus. That of the star BD − 0° 2554, mag. 7, was observed at Teramo on Nov. 9, 1895. This had not been predicted, and was observed by chance. Prof. T. Banachiewicz predicted that of the 4th magnitude star η Geminorum on July 26, 1910; it was observed at seven observatories. Dr. L. J. Comrie predicted that of BD + 18° 1499, mag. 7·4, on Aug. 22, 1924. Both phases were observed at Neu-Babelsberg, and the reappearance at Bergedorf.

From discussion of these phenomena Mr. Witkowski finds a correction of $-0{\cdot}58'' \pm 0{\cdot}23''$ to Hartwig's value of the diameter at distance 1, which is $17{\cdot}552''$. This is in fair accord with Auwers's value $16{\cdot}820''$ derived from the transits of Venus in 1874 and 1882. He finds corrections to the *Nautical Almanac* positions of Venus which agree fairly well with those found with the Greenwich Transit Circle. The observations lead him to suspect some refraction of the stars due to the atmosphere of Venus.

Research Items.

SECRET SOCIETIES AND THE BULL-ROARER.—Mr. Edwin M. Loeb, in a study of tribal initiation and secret societies (*University of California Publications in American Archæology and Ethnology*, vol. 25, No. 3), makes a world-wide survey of the evidence and reviews the theories of previous writers on these features of social organisation. The tribal initiations fall into two classes, those which are exoteric, that is, those to which all members of the tribe are subject, but in which no attempt is made to preserve secrecy as to details, and the esoteric, of which the detailed rites are kept secret. It is out of these latter that the secret society grows, the distinctive feature being that they are exclusive. Secret societies are not, as in the opinion of certain writers, to be connected with the matriarchate, and though totemism and the sib system attach themselves to secret societies in certain areas, tribal customs and secret societies belong to an older stage of social organisation than either. It is noted that while boys' initiations are tribal, that of girls is a family matter. Both boys' and girls' initiations are common among backward peoples. They occur among Negroids and Australians and regionally in the New World, but are lacking among other Mongoloids, and also among Caucasians, with the doubtful exception of the 'mysteries' of ancient Greece. From the distribution it is inferred that these traits are of archaic, possibly palæolithic, origin, and not a matter of recent diffusion. As regards the bull-roarer, earlier theories are to be regarded as untenable. It would be possible to regard it as of independent origin in different regions only if attention were confined to its use as a toy or for purposes of magic. In connexion with initiation and secret societies, it is always associated with a form of tribal marking, a death and resurrection ceremony, and an impersonation of ghosts and spirits. It is tabooed to women and is invariably represented as the voice of spirits; but when found outside the area of initiation rites and secret societies it is neither. As there is no psychological principle which debars women from the sight of the instrument in Oceania, Africa, and the New World, it cannot be regarded as due to an independent origin and it must be inferred that it has been diffused from a common centre.

ANTAGONISM BETWEEN TUBERCULOSIS AND CANCER.—From a statistical survey of the incidence of cancer (carcinoma and sarcoma) among tuberculous and non-tuberculous individuals, Prof. Raymond Pearl concludes that there is a marked and definite incompatibility or antagonism between the two diseases (*Amer. Jour. of Hyg.*, 9, 97; 1929). Active tuberculous lesions were found at autopsy in only 6·6 per cent of 816 persons having malignant growths, and in 16·3 per cent of 816 persons without malignant tumours, but of the same race, sex, and age as the former group. In 886 persons of both sexes and races compared, who were the subjects of active tuberculous lesions, there were but 11 cases of malignant tumours, or 1·2 per cent of the total number, but in a similar group of 886 persons with no recorded tuberculous lesions there were 82 cases of malignant tumours, or 9·3 per cent. It is only when *active* tuberculous lesions are present that the antagonism seems to exist, for *healed* tuberculous lesions occurred with equal frequency in the malignancy and control groups.

BREEDING AND MIGRATIONS OF THE ELEPHANT SEAL.—The two species of seals which we have had opportunities of studying in British waters have distinct but well-defined and compact breeding periods. It is curious that the elephant seal (*Macrorhinus leoninus*) should have so diffuse a breeding period, but the evidences collected by M. E. McLennan Davidson leave the matter in no doubt (*Proc. Calif. Acad. Sci.*, vol. 18, April 1929). On Juan Fernandez young seals have been found from June 10 to Sept. 19; on Guadaloupe Island on Oct. 9, Mar. 5, and May 8; and on the Lower Californian Islands from Nov. 1 to Feb. 1. That is to say, young of the elephant seal have been found in practically every month of the year, although a certain allowance must be made for the fact that the young seals recorded were not in every case new born. Rothschild considered that a regular migration of the adult seals took place to the Chilian coast and the islands near (Juan Fernandez, etc.), but various facts suggest that such a migration is improbable. Elephant seals have been found in the Antarctic pack ice in January, pointing to a movement away from, rather than across, the equator, and the evidence of a prolonged breeding season, as well as the presence of a considerable herd of elephant seals in North American waters during all seasons, also tell against the possibility of a migration to Juan Fernandez.

THE EUROPEAN STARLING IN NORTH AMERICA.—Several attempts were made to establish the European starling in the United States before a successful introduction was made in 1890 at New York City. By 1896 it had become firmly established in this area, and since that time its spread has been so rapid and its hold upon the country so secure that it must now be regarded as a naturalised member of the North American fauna. Within twenty years it had become one of the most abundant birds in the region about New York City and of local occurrence from Maine to Maryland. In another dozen years it had occurred in every State from the Atlantic to the Mississippi, and from the Ottawa and St. Lawrence Rivers in Canada to the Gulf of Mexico, with outlying records in Nova Scotia, Iowa, Missouri, Kansas, and Texas. The conquest has been viewed with some concern. It can scarcely be doubted that so great numbers of a new-comer must affect adversely the numbers of native birds, and it tends to drive some away from the vicinity of houses by ousting them from nesting sites. On the whole, the starling's feeding habits are probably beneficial, but the greatest danger arises from its custom of gathering in enormous flocks after the breeding season, so that harm is caused by over-concentration in crop areas or from the insanitary habits of the birds (May Thacher Cooke, in *U.S. Dept. Agr. Circular*, No. 40). These are complaints which have been proved against the birds in Great Britain.

MALARIA MOSQUITOES OF SOUTH AFRICA.—In Publications of the South African Institute for Medical Research, vol. 4, 1929, pp. 83-170, Messrs. Alexander Ingram and Botha de Meillon contribute the second part of a "Mosquito Survey of certain Parts of South Africa, with Special Reference to the Carriers of Malaria and their Control". It deals with survey work carried out in the eastern and northern Transvaal during a portion of the malarial season, which is considered to last from January to May. The two recognised carriers of malaria in South Africa —*Anopheles funestus* and *A. gambiæ*—differ essentially in their breeding habits. *A. funestus* prefers the edges of slowly running streams, which are in deep shadow, for oviposition, while *A. gambiæ* resorts to shallow pools or puddles exposed to sunlight. *A. gambiæ* shows a decided seasonal prevalence, whereas *A.*

funestus does not appear to exhibit this feature. It is because *A. gambiæ* is much the more numerous of the two species during the malaria season that the authors regard it as the main malaria carrier. They consider that concentration upon the reduction in numbers of this insect is more likely to bring about a diminution of malaria than an indiscriminate attempt against Anophelines in general. The paper includes detailed descriptions of the larvæ and pupæ of certain South African mosquitoes not hitherto described, and these descriptions are accompanied by 28 illustrations.

LUMINOUS SQUIDS.—M. Ishikawa (*Proc. Imp. Acad. Sci.*, Tokyo, January 1929) describes *Abralia japonica*, a new species of luminous squid from the Sea of Japan. The total length of the squid is 116 mm. Numerous minute luminous organs, as dark bluish dots with a paler opaque lens in the centre, are distributed over the ventral surface of the mantle, head, funnel, and the ventral and third arms. On the ventral periphery of the eye are five circular luminous organs, brownish-orange in colour, visible through the outer integument which covers the eye. T. Kishitani (*Proc. Imp. Acad. Sci.*, Tokyo, December 1928) gives a preliminary account of the pair of luminous organs of *Loligo edulis*, which are sunk in the ink sac, one on each side of the rectum. The author has found a coccobacillus in the tubules of the gland tissue which forms the luminous part of the organ, and records the cultural characters of the organism and its action on sugars.

RUST RESISTANCE OF WHEAT.—The resistance of wheat to leaf rust, *Puccinia triticina*, has generally been regarded as a definite, heritable, and relatively stable character. However, several workers have recently demonstrated that differences in external conditions, such as the variation between growth in the field and in the greenhouse, may have an important bearing on the crop's resistance to this disease. C. O. Johnston and L. E. Melchers have now shown (*Journal of Agricultural Research*, **38**, p. 147) that under greenhouse conditions the age of the wheat plant is frequently an all-important factor in determining whether or not infection shall occur. A number of different wheat varieties were tested by inoculations with rust at three distinct stages of growth, after one month, as the period of winter dormancy was just ended and also when the head had fully emerged. Whereas some varieties changed but little in their reaction to the disease, remaining susceptible or resistant throughout their growth period, others showed a definite alteration in their reaction according to their age. Resistance, however, invariably increased towards heading time. From the plant-breeder's point of view, this affords a ready means of testing new varieties, since if resistant in the seedling condition, resistance is assured at all later stages of growth. Thus new hybrids which appear promising but are really worthless on account of their susceptibility to rust may be discarded by means of this simple test before time has been wasted upon them. Wheats showing an increase in resistance with age also showed a variation in the degree of susceptibility of their leaves. The higher the leaf on the stem the greater its resistance to rust, from which the authors suggest that the change in the plant's reaction to the disease is probably correlated with some chemical or physiological change in the leaf.

GREEN ALGÆ OF THE SEA OF JAPAN.—The Pacific Scientific Fishery Research Station in Vladivostok just published in its *Bulletins* (vol. 2, part 2, 1928) a paper by E. S. Sinova on the Chlorophyceæ of the Sea of Japan. The work is based on numerous collections made by many Russian expeditions since 1870 and preserved in the Botanical Gardens and the University of Petrograd, as well as on the personal observations by the author in 1926. The sea bottom is mainly rocky, and the rocks are covered by a continuous carpet of seaweeds. The salinity of the water near the mouth of rivers is 32-33 per mille, and the principal genera of algæ present there are *Scytosiphon*, *Punctaria*, *Ulva*, and *Laurencia*. All the rocky grounds in the northern part of the Bay of Peter the Great are overgrown by the 'sea-cabbage', *Laminaria japonica*, which reaches gigantic dimensions and covers very large areas of the bottom. This seaweed forms a basis of a very important industry, since more than 15 million pounds of the dry weed are exported annually to China for food and for technical purposes. *Sargassum* and *Cystophyllum* occupy large stretches of the bottom, while *Zostera japonica*, *Z. marina*, and *Z. pacifica* form such dense colonies that navigation is made difficult in places. Three new forms of *Laminaria japonica* are described, and *Ceramium subverticillatum* (Grim.) Web., described from New Caledonia, is recorded for the Sea of Japan for the first time. A parasitic seaweed, *Streblonema* (*Ectocarpus*) *parasiticus* (Sauv.), occurs abundantly on *Ceramium cubrum* (Huds.) Ag., *Gracilaria confervoides* (L.) Grev., and on *Camphœlophora hypneoides* J. G. Ag.

DATA ON TERRESTRIAL MAGNETISM.—The March issue of *Terrestrial Magnetism* contains a wide variety of articles on theoretical and observational aspects of the subject; the diamagnetic theory of the daily magnetic variation is discussed by its author, Ross Gunn, and by S. Chapman, and the density and other conditions in the outer atmosphere are described in an interesting speculative paper by H. B. Maris. Hafsted and Tuve report observations, by means of wireless echoes, of abnormal changes of height of the reflecting ionised layer in the upper atmosphere during magnetic storms. There is also a list of preliminary values of the ocean magnetic determinations made by the non-magnetic ship *Carnegie* on its voyage from Balboa to Easter Island and Callas, October 1928 to January 1929; the promptness of publication of such observations is a matter on which the Department of Terrestrial Magnetism of the Carnegie Institution of Washington can feel just pride.

LUMINOSITY OF THE NIGHT SKY.—The Australian Commonwealth Solar Observatory has issued its first publication (*Memoirs*, vol. 1, No. 1), entitled "The Luminosity of the Night Sky". It describes the observations made with a Rayleigh night-sky photometer during 1926 and 1927, first at Canberra, and later at Mount Stromlo, about seven miles away. The green auroral light has high values in March and April, whereas in England the maximum is in October; in each case there is a suggestion of a second maximum near the other equinox. Dr. Duffield, the director, found that the blue part of the spectrum was likewise unusually intense near the equinoxes, and attributes this to nitrogen bands such as occur in the spectrum of polar auroræ, themselves specially frequent at these seasons: hence he supposes that the equinoctial maxima of the green auroral light are due to polar auroræ. At other times of the year, though there is an excess of green auroral light over that to be found in diffuse light from the sun or moon, there is no evidence of excess blue radiation. He therefore accepts Rayleigh's distinction between polar and non-polar auroræ. The period of observation, two years, is too short to indicate whether there are changes of the night-sky light associated with the sunspot epoch, and it is greatly to be hoped that these southern observations will be continued for several years.

THERMO-ELECTRIC PROPERTIES OF METAL CRYSTALS.—The February issue of the *Proceedings of the American Academy of Arts and Sciences* contains an account of Prof. P. W. Bridgman's investigations of the resistivities and thermo-electric properties of rods of metal from a single crystal which he has carried out with aid from the Rumford Fund. The rods, 8 cm. long and 0·3 cm. diameter, are obtained by slow cooling from below upwards of a number of connected glass tubes inclined at different angles to the vertical, and filled with the molten metal. The whole contents of the tubes are then parts of a single crystal. The resistivities of rods of zinc, cadmium, antimony, tin, and bismuth, inclined at various angles to the crystalline axes, were found to follow Kelvin's law that they should be linear functions of the square of the cosine of the angle of inclination. When each rod was soldered between copper leads and the junctions kept at different temperatures, the thermal electromotive forces were found to follow the same law, with deviations in the cases of tin and bismuth which are greater than the possible experimental error.

RECOMBINATION SPECTRA.—A neat experimental method for investigating the neutralisation of positive ions by free electrons has been described by Dr. F. L. Mohler and C. Boeckner in the March issue of the *Journal of Research* issued by the U.S. Bureau of Standards. During the recombination, continuous spectra are emitted in the form of bands shaded to the violet, with their heads close to fundamental lines in the arc spectra of the resulting neutral atoms. The distribution of intensity in the individual bands can be determined photometrically, and at the same time the concentrations of the ions and electrons, and the average thermal energy of the latter, can be found by the probe-wire method of Langmuir and Mott-Smith; by combination of the electrical data and the optical data it is then possible to calculate the chance that a slow electron of specified speed shall fall into any one of the more important unoccupied orbits of the atom in question. An outstanding feature of this work is that it confirms the somewhat surprising conclusion which had been arrived at from the study of the positive column of mercury arcs, that even under favourable conditions recombination in the gas phase is a relatively rare event. The discharge tubes used by Dr. Mohler were of a very simple type, being in fact almost identical with gas-filled wireless valves containing helium or cæsium vapour, and operated in the 'blued' state.

SINGLE CRYSTALS OF SILVER.—Single crystals of various metals have been prepared in the form of rods or wires, and Hauser has obtained etch patterns, showing the crystallographic form, on spherical single crystals of copper and silver. The first preparation of large single metallic crystals possessing the characteristic external form appears to be that carried out in the case of silver by Steacie and Toole and is described in the *Journal of the American Chemical Society* for April. The metal is fused in the absence of air, cooled slowly and then kept at 940° for two days. Dilute nitric acid attacks the faces of the single crystal thus obtained in a specific manner resulting in the formation of a prismatic crystal.

GERMANIUM DICHLORIDE.—The preparation of germanium dichloride, by passing the vapour of the tetrachloride, free from hydrochloric acid, over metallic germanium at about 430°, is described by Dennis and Hunter in the *Journal of the American Chemical Society* for April. Germanium dichloride is a pale yellow solid which is instantly decomposed by moisture and is slowly acted upon by dry oxygen in accordance with the reaction: $2GeCl_2 + O_2 = GeO_2 + GeCl_4$. It readily dissociates on heating, and hence cannot be purified by sublimation. Germanium dichloride is unaffected by alcohol and chloroform but is hydrolysed by water; ammonium hydroxide solution converts it into an orange-coloured substance.

APPARENT INFLUENCE OF AN ELECTRIC FIELD ON THE BOILING POINT OF BENZENE.—It has been shown by Baker that when an electric field is applied to benzene in a tube heated by an oil bath, the boiling point, as registered by a thermometer in the liquid, appears to be considerably raised. The same effect was later observed by Smits, who showed that the vapour pressure remains unchanged and that if the heating is carried out directly with a flame the liquid boils at the normal temperature. Smits attributed the phenomenon to superheating rendered possible by the removal of charged dust particles by the field. In the *Journal of the Chemical Society* for April, J. W. Smith describes experiments which show that the effect is very much reduced by vigorous agitation of the benzene, and when ebullition has commenced before the application of the electric field, then the boiling point remains unaltered. In all cases the vapour temperature has the normal value. The explanation advanced by Smits appears, therefore, to be correct.

LANOLINE RUST PREVENTERS.—The Department of Scientific and Industrial Research has recently published an account (Engineering Research, Special Report, No. 12. London: H.M. Stationery Office) of an investigation of rust-preventing mixtures carried out at the National Physical Laboratory. Preservatives of a greasy nature are more satisfactory than hardening paints or varnishes, and the best results were obtained from lanoline, either brushed on to a steel surface or deposited from solution. Such coatings have very great adhesion to steel even at high temperatures. Benzene is the best solvent to use for making up the lanoline solutions, but solvent naphtha is more suitable for industrial use and is quite satisfactory. Harder coatings can be obtained by the addition of paraffin wax or ceresin, and if the solution is coloured, breaks in the film may readily be detected.

DENICOTINISED TOBACCO.—An account of the so-called 'denicotinised' tobacco is given by E. M. Bailey and others in the Report of the Connecticut Agricultural Experiment Station for 1927 (*Bulletin* 295). Many of these tobaccos are now on the market bearing the advertisement that the bulk of their nicotine has been removed, from which the consumer naturally concludes that the product has been rendered harmless. Actual analyses, however, revealed the fact that on an average only one-half to one-third of the nicotine is removed in the re-sweating process. Further, since the percentage of nicotine varies enormously in different tobaccos, it is possible for a 'denicotinised' product to show as high a nicotine content as some other untreated tobaccos. For example, the lowest percentage of nicotine found in a treated tobacco was 0·75, but certain types of Havana, Porto Rican, and Turkish tobaccos normally contain as little as 1 per cent. From this it is clear that unrestricted indulgence of these tobaccos by people who suffer ill effects from nicotine is unwarranted. The authors conclude with the suggestion that methods may be found which entirely remove the nicotine, though they raise the obvious query whether such refined tobacco would retain the qualities for which smoking is enjoyed.

New Mining Department at Armstrong College, Newcastle-on-Tyne.

ON May 14, H.R.H. the Prince of Wales opened the new Mining Department of Armstrong College. In his opening speech he said, "The industry is confronted with stern competition from overseas. It must be equipped to meet that competition, and I think it is generally agreed that it is to science that we must look in our distress. Science must show the way to an improvement in our methods, and scientific training must be available both for the leaders and the rank and file, so as to ensure that no single ounce of energy is lost in the tug-of-war against our competitors."

The demand that Armstrong College should intensify and enlarge its share of work of scientific research in the interests of the coalfields it mainly serves has recently become specific. The coal owners of Durham and Cumberland, the Federation of Iron and Steel Manufacturers, the Department of Scientific and Industrial Research and the coke and gas industries, have co-operated with the College in the formation of a committee to supervise and encourage the prosecution of researches bearing directly on their respective industries. This work is now well in hand; valuable reports have already been issued, and more may be confidently expected in the near future. Similar co-operation between the College and the Fuel Research Board has begun: a physical and chemical survey of the coal seams in the northern coalfields is in progress, the chief purpose being to obtain an exact knowledge of the properties of these seams. This work is being carried out at present in temporary buildings, but it will shortly be transferred to the top floor of the new building.

The Department of Mining in Armstrong College has long and fine traditions behind it. It forms the oldest mining school in Great Britain, for it dates back in one form or another to the year 1837. Many of the foremost men in the mining industry to-day received their training in it. The present head of the Department is Prof. Granville Poole, who has designed the new building which now provides adequate facilities for the teaching of mining and the prosecution of research.

The erection of this building has been made possible only by generous grants from the Miners' Welfare Fund. The sum of £20,000 was subscribed by the Central Committee of the Fund and £10,000 from the Northumberland District Committee. Anonymous donors have contributed nearly £5000 to the equipment of the building and a further sum of £15,000 is required. The building will occupy a central position when the general scheme for the development of the College is completed. The architect is Mr. Dunbar Smith, of London, who was also the architect for the new College Library and for the National Museum of Wales, one of the noblest buildings erected in Great Britain within recent years.

Apart from the rooms set apart for research, the Department has several prominent features; for example, an exhibition hall containing plant and models of great educational value, and products from modern carbonising and hydrogenating plants, etc., also a specially equipped laboratory housing plant for the dressing of minerals.

The courses of the Department are arranged to meet the requirements of those who wish to specialise in any branch of mining, and the diploma and degrees obtainable are accepted by the Board for Mining Examinations in lieu of two years' practical experience in a mine.

Insect Nutrition and Metabolism.

THE subject of nutrition and metabolism in insects is highly important, in that its adequate exploration is likely to provide fresh viewpoints for problems of insect control. At the same time its relation to such insect products as silk, lac, honey, and wax should not be overlooked. At the present time, knowledge of the metabolic processes of insects is limited to scattered experiments and observations, usually confined to individual species, and of too inadequate a character to admit of reliable generalisations being made. The literature is very extensive and, for that reason, imparts the impression that a large amount of work has already been accomplished. A survey of any small branch in this field will, however, reveal how much of the available information is of a comparatively trivial or incomplete character, and what an infinitesimal amount of really fundamental knowledge has, so far, been gained.

In the *Transactions of the Entomological Society of London*, 1928, Part 2, Mr. B. P. Uvarov, senior assistant in the Imperial Bureau of Entomology, has brought together the results of all the work done on the subject of insect nutrition and metabolism. His memoir takes the form of an admirable introductory survey (65 pp.) of the range of problems involved, together with a bibliography of nearly six hundred titles. In the collation and examination of so large a mass of literature, the author has done a substantial service to entomology and laid the basis and provided a guide for future research.

If one selects, for example, the enzymes involved in the digestive processes of insects, rather a surprising amount of data will be found available, but much of the material is the result of old, or of imperfect, methods of technique. There is also the fact that the part played by micro-organisms living in the digestive tract further complicates the subject. The need for clearly ascertaining which enzymes are produced by the insect and which by micro-organisms of symbiotic or other relationship is abundantly evident. With plant-sucking insects we have evidence that they are capable of converting starch into sugars, but we know nothing concerning their utilisation of the protein constituents of cell sap. Buchner went so far as to conclude that the symbiotic micro-organisms of aphids, coccids, etc., are able to utilise atmospheric nitrogen and so make up for a supposed deficiency in nitrogen absorbed by such insects from their plant hosts. It is, however, abundantly clear that there is no positive evidence indicating that sucking insects do not obtain and utilise all the nitrogen they need from the cell contents: we have to admit that the rôle of the symbionts is still unsettled.

Again, the problem of cellulose digestion in insects is very far from being settled in spite of the existence of tens of thousands of plant-feeding species. The presence of a cellulase has been found in very few insects and, for the vast majority of species, it would appear probable that, if cellulose is digested at all, it is by the intervention of micro-organisms, as has been so well demonstrated by Cleveland in the case

of termites. We know surprisingly little concerning the nutritional requirements of blood-sucking insects which are concerned with the transmission of the pathogenic agents of certain virulent diseases. We need to know the length of time such insects can exist in the absence of a blood meal, the extent to which digestion of blood requires the interaction of micro-organisms, the influence of different types of blood upon fecundity, and the extent to which the selection of one mammalian host in preference to another is a chemical or a biological problem.

These few comments will serve to indicate the nature and importance of some of the problems involved. It is to the credit of the Dietetics Subcommittee of the Civil Research Committee that it directed attention to the need for examination of the nutritional problem in insects. Through the Empire Marketing Board it was able to arrange with the Imperial Bureau of Entomology to produce a collated bibliography of the whole subject, and Mr. Uvarov's memoir was the result. On the submission of the MS. to the Civil Research Subcommittee, the latter body approached the council of the Entomological Society of London, through the Empire Marketing Board, with a view to its publication. It must be added that the financial provision was made by the Empire Marketing Board, and that it affords yet another example of the breadth of view and wise foresight exercised by that Board in the furtherance of applied biological research.

The inception, preparation, and publication of this memoir reflects the greatest credit on all concerned. It may be added that Mr. Uvarov's actual summaries of the papers listed in his bibliography have been deposited in the Reid Library of the Rowett Research Institute for Animal Nutrition, Aberdeen. Arrangements have also been made for a set to be placed in the Science Library at South Kensington, where they will likewise be available for consultation. A limited number of copies of Mr. Uvarov's memoir are available on application to the Secretary, Committee of Civil Research, 2 Whitehall Gardens, S.W.1. A. D. IMMS.

Annual Visitation of the Royal Observatory, Greenwich.

AT the annual visitation of the Royal Observatory, Greenwich, by the Board of Visitors on Saturday, June 1, the Astronomer Royal presented his report, which describes the work of the observatory during the year ended on May 10. The observations with the transit circle numbered nearly nine thousand, embracing the sun, moon, planets (of which special attention was paid to Vesta, owing to its value for determining the equator point), fundamental stars, and stars needed for comparison with Eros at the time of its near approach to the earth in 1930–31. The correction to the longitude of the moon as calculated from Brown's tables is $+5{\cdot}51''$ from the limb and $+5{\cdot}83''$ from the crater Mosting A. The correction has been diminishing at the rate of a third of a second per annum since Brown's tables were introduced into the almanacs in 1923. The early observations of the sun and moon, from 1751 onwards, have been re-reduced; it is found that the longitudes deduced from the declinations are more trustworthy in the early years than those from the right ascensions. The results give support to the theory that there are variations in the earth's rate of rotation; they also indicate a secular acceleration of the sun's longitude, the amount of which is $+0{\cdot}78''$ in a century.

Observations with the Cookson Zenith Telescope show that the variation of latitude in recent years has been abnormally small; the large amplitude of seven years earlier has not been repeated.

The 28-inch equatorial has been used for double star observation; 282 stars have been measured during the year, 44 of which are separated by less than half a second; a new working list of some 2000 pairs discovered by Dr. Aitken has been prepared. The old water-clock used for driving this instrument, and its predecessor the Merz equatorial, since Airy's days has been superseded by an electric drive of the Gerrish type, which was on view for the first time at the visitation. The Astronomer Royal gratefully acknowledges the help given in preparing the plans by Mr. F. J. Hargreaves, who had used a similar drive successfully on his small equatorial at Kingswood, Surrey. It was with this instrument that he was the first to photograph the comet Grigg-Skjellerup at its return in 1927.

Thirty-one stellar parallaxes were determined with the Thompson 26-inch equatorial during the year, bringing the total up to date to 400. A useful economy has been introduced of taking two parallax fields on the same plate; this halves the time spent in development.

The 30-inch reflector is being used for the determination of 'colour temperature' of stars. The absolute temperatures are obtained by comparison with the positive crater of a carbon arc lamp, which is mounted on the roof of the octagon room, 600 feet away. Twenty-four early-type stars, distributed as uniformly as possible round the northern hemisphere, have been selected as standards; forty other stars have now been compared with these; the comparisons being made at the same altitude in each case. Some notes on B-type stars of abnormally low temperature were published in the *Monthly Notices* last year.

With the astrographic equatorial, plates are being taken for comparison with those taken twenty-five to thirty years ago, in order to determine proper motions The result of this study for the zones from Decl. $+64°$ to $+72°$ is now in the press. The sunspot curve gives indications of a double peak, in 1926 and 1928 respectively. Daily spot numbers, both of the whole disc and of the central region, are sent to Zurich for the Bulletin which is published there under the auspices of the International Astronomical Union.

The magnetic elements determined at Abinger for the year 1928 are: Decl. $12°\ 47{\cdot}0'$ W.; Hor. Force, 0·18564; Vert. Force, 0·42941; Dip, $66°\ 37{\cdot}3'$; the Decl. is diminishing about $12'$ per annum.

The mean temperature of the year ending on April 30, 1929 (misprinted 1928 in the report), was $48°{\cdot}7$, or $0°{\cdot}8$ below the average. Frost occurred on 71 days; the rainfall was 20·46 inches, or 3·78 below the average. March, with 0·038 inch, was the driest month ever recorded at Greenwich.

The performance of the two Shortt sidereal clocks has been very satisfactory; the temperature in the clock cellar is now maintained at $62°{\cdot}8$ Fahr. The progressive increase of losing rate still continues; it is proposed to substitute a bob of invar on one of the clocks.

Daily comparisons of time are made with Paris, Nauen, Annapolis, and Bordeaux. In all four cases the residuals appear to show an annual wave.

Allusion is made to the eclipse expedition to Kedah and Siam. The total equipment weighed ten tons. Unfortunately, no results were obtained in the investigation of the Einstein bending of light; but some results on the corona and prominences were obtained at Alor Star. A. C. D. CROMMELIN.

Wisconsin Limnology.

THE veteran limnologist, Dr. E. A. Birge, together with Dr. Chancey Juday and other collaborators, has made several additions to the detailed study of Wisconsin lakes in the *Transactions of the Wisconsin Academy*, vol. 23, *Proceedings of the American Philosophical Society*, vol. 66, and in *Ecology*, vol. 8. The Academy papers deal with the temperature of the bottom deposits of Lake Mendota, with the chemical composition of its larger aquatic plants and with the phosphorus content of that and other Wisconsin lakes. Temperatures were measured in the mud of Lake Mendota down to 5 metres, in depths of water from 8 m. to 23·5 m. The data accumulated are used to calculate the annual heat-budget. At the shallowest station this amounted to 2950 calories per sq. cm. and 1100 calories at the deepest. Preliminary data on the heat-budget of Karluk Lake, Alaska, are given in *Ecology*, July 1927. These are compared with the values given by lakes in Central Europe.

Supplementing a previous study of the composition of *Cladophora* and *Myriophyllum*, analyses of *Vallisneria* and *Potamogeton* are now given. Rickett had previously shown that Mendota, 10·4 sq. kilometres in area, yielded, in dry weight, 1112 metric tons of *Potamogeton* and 736 of *Vallisneria*. Of these, the latter has an ash content of 25·2 per cent, the former 11·4 per cent. Their influence upon the water and soil of the lake must, therefore, be very considerable. The analyses are unusually detailed and record the amounts of certain important minor constituents, such as phosphorus, iron, manganese, and silica, which are frequently omitted.

The organic matter content of lake waters is considered in a preliminary survey (*Amer. Phil. Soc.*), which, however, contains analyses from forty-four lakes. These are grouped into *autotrophic*, which derive their organic matter from internal sources only, namely, from the phytoplankton and attached vegetation, and *allotrophic*, into which drainage brings soil and marsh extractives. For each lake the organic matter is a fairly definite quantity, showing no great variation either with depth or time. This is in striking contrast to the oxygen content, which is often greatly reduced in the deeper cold water, the hypolimnion; this during summer remains unmixed with the warm epilimnion.

Analyses were made of the waters of eighty-eight lakes to determine the soluble phosphorus existing as phosphate, also the phosphorus in organic combination. This was done in order to ascertain whether the simple yearly cycle, observed in the open sea, could also be traced in these lakes. The marine workers found a winter maximum and a minimum in early summer, lasting until August, the surface waters being, during the summer, almost or quite devoid of inorganic phosphorus, and the deeper waters—in shallow seas—being much reduced. In the lakes, however, observations made in May, soon after the disappearance of the ice, and in July or August, were complicated by two factors—the very minute amount of inorganic phosphorus and its regeneration from the plankton. Accordingly, no such simple seasonal cycle was revealed. Possibly the rate of regeneration, rather than the absolute amount of phosphorus, may here be the limiting factor.

In *Ecology* (**8**, No. 4; 1927) an account is given of the occurrence of two crustacea, *Pontoporeia affinis* and *Mysis oculata* var. *relicta*, which are regarded as 'marine relicts'. Though thoroughly studied in Europe, their American distribution is imperfectly known. It was found that *Pontoporeia* occurs chiefly in the hypolimnion, where the supply of oxygen may fall below 1 c.c. per litre. The breeding season extends from December to May. *Mysis* was found in two lakes. During summer it remains on the bottom during daytime, but may even reach the surface at night. The breeding season extends from October to May.

University and Educational Intelligence.

CAMBRIDGE.—The solicitors carrying out the will of the late Mr. John Humphrey Plummer state that, in view of the many conflicting and wholly unauthorised statements that have appeared, the time has arrived when some authoritative statement should be made concerning the benefaction which will accrue to the University. The residue of the estate is to be applied in perpetuity for the promotion and encouragement of education in chemistry, biochemistry, physical science, or such other allied subjects in the University as the trustees shall think fit. The testator further expressed his desire and intention that his trustees should, as soon as possible, establish and endow a professorship or professorships, each of the annual value of £1200 in accordance with a scheme to be devised. The testator further expressed the wish that the trust should be known as the John Humphrey Plummer Foundation. The trustees are advised that the estate should yield an income to the University of approximately £10,000 a year.

The Drapers Company has made a grant of £1000 per annum for a further period of 10 years to the School of Agriculture.

Dr. H. B. Roderick and Mr. G. Stead have been reappointed University lecturers in medicine.

EDINBURGH.—Principal Sir Alfred Ewing announced at the meeting of the University Court on May 27, in connexion with the proposed internal reconstruction of the medical buildings at Teviot Place, that gifts have been intimated for this purpose of £20,000 from Sir William Dunn's trustees, and £35,000 from the Rockefeller Foundation, making a sum of £55,000 in all. This, along with other moneys available, now secures the carrying out in its entirety of a scheme drawn up by Mr. Balfour Paul, architect, in consultation with the heads of the departments concerned, whereby the medical buildings, erected in 1880, will be radically altered in their internal arrangements, so as to bring them in line with the most modern requirements for teaching and research. The external aspect of the buildings, as designed by the late Sir Rowand Anderson, will remain unaltered. The work will be begun in the summer vacation. Certain portions of the reconstructed building will in future be associated with the name of Sir William Dunn in recognition of the generous gift from his estate.

LONDON.—The following doctorates have been conferred: D.Sc. in metallurgical chemistry on Mr. J. C. Hudson (Imperial College, Royal College of Science, and Royal School of Mines), for a thesis entitled "Third (Experimental) Report to the Atmospheric Corrosion Committee (of the British Non-Ferrous Metals Research Association)"; D.Sc. in agricultural chemistry on Mr. V. Subrahmanyan (Rothamsted Experimental Station), for a thesis entitled "Biochemistry of Waterlogged Soils".

MANCHESTER.—Mr. J. B. M. Hay, lecturer in engineering, has resigned on his appointment as head of the Civil Engineering Department in Bradford Technical College.

Applications are invited for two Grisedale biological scholarships in, respectively, botany and zoology, each of the value of £200. Applications should reach the registrar by at latest June 22.

READING.—Dr. T. Franklin Sibly, principal of the University of London since 1926, has accepted the invitation of the council to become vice-chancellor of the University in succession to Dr. W. M. Childs, who is retiring in September next.

AT the time of going to press, the following results of Parliamentary elections in University constituencies have been announced:—Cambridge (2): Mr. J. J. Withers, Mr. G. H. A. Wilson. London: Dr. E. Graham Little. Combined English (2): Sir Martin Conway, Miss E. Rathbone. Wales: Mr. E. Evans. Queen's, Belfast: Col. T. Sinclair.

THE New Education Fellowship (English section) gives prominence in its annual report for 1928 to the subject of parent education. At a conference which it called last September, it was resolved to form a National Council for Parent Education and Child Study, and a provisional committee was appointed with Dr. Basil Yeaxlee as chairman to undertake the preliminary work with the aim of correlating and extending the efforts of existing organisations for forming parent-teacher associations all over Great Britain, child-psychology study groups, training of study-group leaders, publication of pamphlets and magazines for parents, formation of libraries, panels of speakers, etc. The movement will be stimulated by a visit to Great Britain this summer of some of the leaders for similar movements in America and by the fifth international New Education conference to be held at Elsinore on Aug. 8–21. The Fellowship, of the English section, of which Sir Michael Sadler is president, besides organising biennially international conferences, maintains libraries and information bureaux, publishes magazines, and in other ways promotes co-operation between educationists and between parents and teachers. Its watchwords are: Release spiritual and creative power in the child; study and respect the child's individuality; educate through innate interests; encourage co-operation rather than competition; co-educate; educate for service. The general theme of the Elsinore conference will be "The New Psychology and the Curriculum".

A CENSUS of graduate research students in chemistry in the United States in 1927 shows that they numbered 1934 in one hundred and forty universities, as follows: in organic chemistry 570, general and physical 430, industrial and engineering 183, physiological 134, inorganic 116, agricultural 89, colloid 79, analytical 75, nutrition 58, catalysis 28, food 27, sanitary 25, photographic 25, metallurgical 21, five other sub-heads 74. The census has been taken annually for four years by the Research Information Service Division of the National Research Council, Washington, and discloses a steady growth in the total number of such students (1700, 1763, 1882, 1934), although under the various sub-heads the numbers fluctuate. In addition to these students, 1047 members of the faculty staffs were engaged in chemical research. In the pamphlet giving the results of the census (*Reprint and Circular Series of the National Research Council*, No. 84. Washington, D.C.: National Academy of Sciences; price 20 cents) figures are given separately under each sub-head for each university, together with the name of the head of the department of chemistry. In the same pamphlet are statistics showing the number and amounts of fellowships and other stipends received by graduate students in chemistry in 119 universities in the United States in 1927–28. Of the total number of such students, 45 per cent received no financial assistance either from the university or from outside organisations. More than one-third of these self-supporting students (418) belonged to Columbia University, New York.

Calendar of Patent Records.

June 9, 1683.—Great public interest was aroused by the patent granted on June 9, 1683, to Robert Fitzgerald and others for his process for obtaining fresh from salt water. A previous patent granted in 1675 to William Walcot for a similar invention was voided by the Privy Council on the ground that it had not been put into operation, and it is said that Fitzgerald's prescription, certified by Robert Boyle, was sent by Charles II. to the Lord Mayor "to be kept lest a secret of so great importance might come to be lost". But it was Fitzgerald's process that eventually proved a failure and Walcot's that triumphed. In 1695 an Act of Parliament was passed restoring Walcot's rights and granting him a 35 years' monopoly.

June 9, 1842.—The direct-acting steam hammer, first reduced to a practical form by James Nasmyth, was patented by him on June 9, 1842.

June 12, 1704.—The rise of the Irish linen trade is due very largely to Louis Crommelin, the leader of a small band of Huguenots settled in Belfast, who contracted with William III. to supply the requisite machinery and material and to teach the Irish the art of linen manufacture in return for the interest on his expenditure and £300 a year. On June 12, 1704, the Signet Office in London records a patent granting to the Board of Trustees of the Linen Corporation and the Lieutenant Justices of Ireland a yearly sum of £1180 for ten years for the purpose of encouraging the manufacture, the payment of £200 a year to Crommelin "for his paines and care in carrying on the work", and £120 a year to three assistants; with a pension of £60 a year to a French clergyman for the Huguenot colony.

June 12, 1806.—The purification of coal gas with lime was suggested in the early days of gas manufacture. Edward Heard, on June 12, 1806, patented a process in which the lime was charged with the coal in the retorts, but the proposal did not come into general use until it was reintroduced by W. J. Cooper in 1882.

June 13, 1551.—The first patent of which there is any record in France is that granted for ten years by Henry II. to Theseo Mutio, an Italian, on June 13, 1551, for making all kinds of Venetian glass. The manufacture was not successful, but the experiment paved the way for the subsequent encouragement of Italian workmen by Henry IV.

June 13, 1772.—William Tutin's is a noteworthy name in the history of the manufacture of shoe buckles, an important Birmingham industry in the eighteenth century. Tutin was the inventor of the alloy—made of brass, antimony, and tin—called "Tutania", of which most of the buckles of the period were made, and on June 13, 1772, he was granted a patent for a process of japanning buckles "so as to equal and far exceed in cheapness and wear the common blue-coloured buckles, which are coloured by the heat of the fire, and are liable to be damaged by wet".

June 13, 1922.—Insulin, the pancreas extract used in the treatment of diabetes, was isolated by Dr. G. F. Banting and Dr. C. H. Best, of the University of Toronto, and in order to safeguard the public interest the method of extraction was patented in Great Britain on June 13, 1922. The University of Toronto invited the Medical Research Council to assume the responsibility for its production in Great Britain and conveyed the patent rights to the Council as a free gift. The word 'insulin' is due to Sir Edward Sharpey-Schafer, who coined it about 1911 in anticipation of the discovery.

Societies and Academies.

LONDON.

Royal Society, May 30.—O. W. Richardson and P. M. Davidson: The energy functions of the H_2 molecules. The terms in the expansion of the force function are determined for certain states by various methods and show satisfactory agreement. Negative total energies, heats of dissociation and other constants of about thirty H_2 states are tabulated. Curves are drawn for the mean kinetic energy of the electrons of certain states at various nuclear separations. An appendix contains a theorem on the mean energy of a system of particles in any condition of periodic motion, when some of the particles are fixed.—E. K. Rideal, C. P. Snow, F. I. G. Rawlins, and A. M. Taylor: Infra-red investigations of molecular structure (1).—C. P. Snow, F. I. G. Rawlins, and E. K. Rideal: Infra-red investigations of molecular structure (2). The vibration-rotation band spectrum of nitric oxide proves to be a fundamental, with its centre at 1882·9 cm.$^{-1}$, with the fine-structure consisting of P, Q, and R branches with at least 42 rotation bands in each of the P and R branches. The molecular constants derived from the separation of the fine-structure bands (3·35 cm.$^{-1}$) corresponds almost exactly with those obtained from electronic band spectral data. The presence of a Q branch is in accordance with the gyroscopic character of an odd-electron molecule. The facts relating to the ground state of nitric oxide, its physical magnitudes, and its electronic angular momentum about the nuclear axis, form a consistent whole.—A. Müller: The connexion between the zigzag structure of the hydrocarbon chain and the alternations in the properties of odd and even numbered chain compounds. Starting from the fact that the CH_2-groups are arranged in a zigzag line, it is shown that there must exist an essential difference in the structure of the odd and even numbered substances. This difference accounts for the alternations of properties.—O. W. Richardson and F. S. Robertson: The emission of soft X-rays by different elements at higher voltages.—L. P. Davies: The soft X-ray emission from various elements after oxidation. The effect of oxidation on the total soft X-ray emission from the following elements has been studied: Silicon, manganese, iron, cobalt, nickel, copper, molybdenum, palladium, and tungsten. The efficiency of the oxide seems to be the average efficiency of the oxygen and element present.—D. L. Chapman and W. K. Hall: A study of the catalysis by silver of the union of hydrogen and oxygen. The new method of Hughes and Bevan was used and the conclusions confirmed by direct measurements of the falls of pressure which occur when the gases, separately and mixed together, are brought into contact with a large surface of silver. The mechanism of the action seems to be one of alternate reduction and re-oxidation of an oxide film. The fact that a film formed at low temperature is more effective than one formed at a higher temperature suggests that some of the molecules of silver oxide in the former are in relatively unstable positions, and therefore more active chemically.—R. H. Fowler and A. H. Wilson: A detailed study of the 'radio-active decay' of, and the penetration of α-particles into, a simplified one-dimensional nucleus. The authors solve exactly for a simplified nucleus the problem of α-particle disintegration (determination of the *complex* characteristics of the wave-equation with the proper boundary conditions), and discuss the converse problem of the penetration of an α-particle into the nucleus from without.—G. I. Finch and D. L. Hodge: Gaseous combustion in electric discharge (3). Combustion of dry detonating gas in the direct current discharge is primarily determined by the ionisation of both the constituent molecules of the gas. Electrostatic forces keep apart positively charged ions, unless such forces are counteracted by some other agency; one such agency is negatively charged metal atoms sputtered from the cathode which, by forming electrically neutral metal-gas complexes with positive ions, overcome electrostatic repulsion and thus enable combustion to proceed.—G. I. Finch and J. C. Stimson: The electrical condition of hot surfaces during the adsorption of gases (3). A hot platinum surface exhibits a charge when *in vacuo* or in contact with gases. With alternate treatment with oxygen and hydrogen at 500° C., it will exhibit a charge in hydrogen or *in vacuo* at room temperature. Heating at 850° destroys such superactivity. The charge due to any gas can be rapidly removed by evacuation at 850°. The destruction of the superactive condition is due to a structural change in the arrangement of the surface atoms akin to sintering.—J. M. Robertson: An X-ray investigation of the structure of naphthalene and anthracene. Using the rotating crystal photographic method, the general and statistical considerations of the reflections indicate a periodic structure parallel to the c axes of the crystals. Geometrical structure factors are developed and the dimensions of the molecules calculated differ only slightly from those of Bragg's tetrahedral structure. Thus the tetrahedral properties of the carbon atom are maintained in aromatic structures.—K. Majumdar: The arc spectrum of chlorine. The spectrum has been photographed in the region λ6400-8700. The ionisation potential is calculated as 13·1 volts.—K. R. Rao: The arc spectrum of germanium. Observations have been extended to λ1630 and about fifty new lines have been added, most of which have been classified. The ionisation potential of Ge I is 8·09 volts approximately.—U. Nakaya: On the emission of soft X-rays by different elements, with reference to the effect of adsorbed gas. The absorption of these rays increases with the amount of the adsorbed gas molecules on the photoelectric plate, while the excitation decreased with the presence of gas molecules. Reliable data were secured by bombarding the photoelectric plate and target to red heat in the highest vacuum and afterwards reducing the oxide films on these surfaces with hydrogen.—N. F. Mott: The scattering of fast electrons by atomic nuclei. The scattering of electrons by an atomic nucleus is investigated, using the wave equation of Dirac and a scattering formula obtained which gives the spin-relativity correction to be applied, for fast β-particles, to the usual Rutherford formula.—L. J. Freeman: Further investigations of the spectrum of ionised nitrogen (N II). Nine terms belonging to a quintet system have been identified and two new terms of the triplet system. Some 75 lines have been newly classified.—A. E. Gillam and R. A. Morton: The absorption spectra of halogens and inter-halogen compounds in solution in carbon tetrachloride.—R. A. Frazer and A. J. Duncan: On the criteria for the stability of small motions.—R. A. Frazer and W. J. Duncan: On the numerical solution of equations with complex roots.—G. C. McVitie: On Einstein's unified field theory.

Physical Society, May 10.—W. E. Sumpner: Heaviside's fractional differentiator. The paper deals with (1) Heaviside's experimental methods; (2) the index operator, its definition and justification; (3) its use with Leibnitz's theorem; (4) its use with binomial and exponential expansion; (5) functions of the operator; (6) Heaviside's operators; (7) examples; (8) the impulse function.—J. H. Awbery:

A simple method of fitting a straight line to a series of observations. The method has a rational basis, and can be carried out much more quickly than the method of least squares.—**E. W. H. Selwyn**: Arc spectra in the region λ1600–λ2100. A simple method is described of photographing ordinary arc spectra down to about λ1600. Additions have been made to the analysis of the spectra of Mg I, Be I, and B I.—**K. R. Rao**: The spectrum of trebly ionised thallium.—**G. A. Wedgwood**: The elastic properties of thick cylindrical shells under internal pressure. An experimental investigation of the usually accepted theory. Longitudinal and diametral extensions were determined of a number of steel cylinders subjected internally to hydrostatic pressure, the cylinders being closed at the ends by covers secured to the shell itself. Discrepancies seem to be due to the non-isotropic nature of the material.

PARIS.

Academy of Sciences, April 29.—**Henri Villat**: The alternating vortices of H. Bénard in a canal of finite width.—**E. Mathias**: Contribution to the study of fulminating matter. Its two modes of decomposition. A review of descriptions by witnesses of cases of globular lightning. Certain of these describe the dissipation as without noise; in others, and these form the majority, the disappearance was accompanied with very violent explosions.—**J. A. Schouten**: The geometrical signification of the semi-symmetrical property of an integral connexion, which leaves invariant the fundamental tensor.—**Georges Durand**: A manner of conceiving the theory of envelopes.—**D. Pompeiu**: Certain systems of linear equations and an integral property of functions of several variables.—**René Lagrange**: Certain functions associated with the functions of Legendre.—**E. Hille** and **J. Tamarkin**: A relation between the results of Minetti and Valiron.—**Alex. Véronnet**: There are three distinct dynamics, and three only, corresponding to the three spaces of Euclid, Riemann, and of Cartan.—**Lucien Féraud**: Some applications of Pfaffian systems.—**René Lucas**: Remark on the equations of electromagnetism.—**Neronoff**: The law of attraction.—**R. Hocart**: The diamagnetism of some binary halogen compounds. The dismagnetism of the ions is not strictly additive, and hence it is not possible to describe the diamagnetic properties of substances by means of a single coefficient. The coefficients of solutions of hydrochloric acid, common salt, and potassium chloride are given, the accuracy being from 0·1 per cent to 0·3 per cent.—**G. Föex**: The diamagnetism of the crystal of azoxyanisol and the precession of Larmor.—**Jean Becquerel** and **W. J. de Haas**: The fundamental law of paramagnetic magnetisation of a crystal and the law of paramagnetic rotatory dispersion.—**J. Gillies**: The trajectory 3*d* in the ionised atoms P II, S II, S III, and Cl III. Quadruplets of Cl. III.—**Charles Nordmann**: A new method for the reproduction of colours.—**Marinesco**: The structure of solutions of gelatine. A study of the relations between the dielectric constant of gelatine solutions and their concentration.—**Nahmias**: The evaluation of the α-radiation of the active deposit of actinium by the measurement of its β-radiation.—**H. Herszfinkiel** and **H. Jedrzejowski**: The conditions of formation of groupings of radioactive atoms.—**René Delaplace** and **G. Rebière**: The irradiation of ergosterol: the action of the ultra-violet rays of quartz and of the soft X-rays. Diagrams are given showing the changes in the ultra-violet spectrum of ergosterol produced by various times of exposure to ultra-violet light. Soft X-rays produce effects qualitatively similar.—**Antoine Willemart**: The isomerisation of some acetylene carbinols into ethylene ketones. The transformation of alcohols of the type $R_1R_2C(OH)-C\equiv CR_3$ into the ketones $R_1R_2C=CH-CO-R_3$ either by alcoholic sulphuric acid or through the chlorides is a general reaction. Several examples are given.—**Huan**: The action of ethylmagnesium bromide on the tetrethyldiamide of succinic acid.—**L. Royer**: The possible asymmetry of the corrosion figures obtained by an active isotropic liquid. Results on the corrosion of calcite crystals are given which are in general agreement with the views of Hettich.—**A. Amstutz**: The crystallophyllian conglomerates of Mayombe, in the French Congo.—**P. L. Violle** and **A. Giberton**: The antitoxic properties of calcium towards sparteine sulphate. A guinea-pig survived indefinitely the injection of a mortal dose of sparteine sulphate when the latter was mixed with a solution of calcium chloride.—**Marc Bridel**: Researches on the variation of colour in plants in the course of their drying. The glucoside of *Lathræa clandestina* is aucuboside (aucubine).—**Charles Pontillon**: The pigmentation of *Sterigmatocystis nigra* cultivated on fatty media. The yellow coloration sometimes observed in *Sterigmatocystis nigra* cultivated on fatty media is a consequence of the lack of homogeneity of the culture medium due to the mode of preparation of the mineralised gelose solution.—**René Wurmser** and **Jean Geloso**: A glucose derivative, a constituent of the oxido-reduction equilibrium of the cells.—**Mme. L. Randoin** and **R. Lecoq**: The primordial rôle of the alimentary equilibrium in the utilisation of lactose.—**Edouard Chatton**, **André Lwoof**, and **Mme. Marguerite Lwoff**: The infraciliatures and the genetic continuity of recessive ciliary systems.

Official Publications Received.

BRITISH.

Memoirs of the Indian Meteorological Department. Vol. 25, Part 3: Data of Heavy Rainfall over Short Periods in India. Pp. 109-143. (Calcutta: Government of India Central Publication Branch.) 2.2 rupees; 4*s*.

Supplement to the Journal of the Indian Mathematical Society, Vol. 17. Report of the Sixth Conference of the Indian Mathematical Society held at Nagpur in December, 1928. Pp. iii+24. (Madras.)

Annual Report of the Zoological Society of Scotland for the Year ending 31st March 1929. Pp. 63+8 plates. (Edinburgh.)

Indian Central Cotton Committee: Technological Laboratory. Bulletin No. 19, Technological Series No. 14: Further Tests on the Effect of Temperature and Humidity on Cotton Spinning. By A. James Turner. Pp. 17. (Bombay.)

Quarterly Journal of the Royal Meteorological Society. Vol. 55, No. 230, April. Pp. 103-214. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

Apia Observatory, Apia, Western Samoa. Report for 1926. Pp. 96. (Wellington, N.Z.: W. A. G. Skinner.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1204 (Ae. 365): Wind Tunnel Experiments on the Design of an Automatic Slot for R.A.F. 34 Section. By F. B. Bradfield and F. W. G. Greener. (T. 2682.) Pp. 11+4 plates. 9*d*. net. No. 1215 (Ae. 374): The Accelerated Motion of a Cylindrical Body through a Fluid. By H. Glauert. (T. 2727.) Pp. 10. 9*d*. net. (London: H.M. Stationery Office.)

The Physiological Society. Session 1929-30. Rules, List of Members and Dates of Meetings. Pp. 32+viii. (London: University College.)

Proceedings of the International Mathematical Congress held in Toronto, August 11-16, 1924. Edited by Prof. J. C. Fields, with the collaboration of an Editorial Committee. Vol. 1: Report of the Congress; Lectures; Communications to Sections I and II. Pp. 935. Vol. 2: Communications to Sections III, IV, V and VI. Pp. 1006. (Toronto: The University of Toronto Press.)

FOREIGN.

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1928. Pp. xliii+269+6 Tafeln. (Bern: Verlag Paul Haupt.)

Ministry of Agriculture, Egypt: Cotton Research Board. Sixth Report, 1925-27. Pp. v+104+29 plates. (Cairo: Government Press.) 15 P.T.

Ministry of Agriculture, Egypt: Technical and Scientific Service (Botanical Section). Bulletin No. 87: The Branching of Egyptian Cotton Plants. By Dr. J. Templeton. Pp. 5+2 plates. (Cairo: Government Press.) 3 P.T.

Scientific Papers of the Institute of Physical and Chemical Research. No. 188: The Uranium-Thorium-Ratio in Monazites. By Satoyasu Iimori. Pp. 229-236. 20 sen. Supplement, Vol. 10, No. 9: Geographical Distribution of certain Minerals in Japan. By Satoyasu Iimori and Toyofumi Yoshimura. Pp. 5-46. 45 sen. (Tokyo: Iwanami Shoten.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 2, Part 8: Neogene Shells from some Provinces of Chūgoku. By Matajiro Yokoyama Pp. 363-368+1 plate. (Tokyo: Maruzen Co., Ltd.) 45 sen.

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 25: Biennial Survey of Education, 1924–1926. Pp. iii+1204. (Washington, D.C.: Government Printing Office.) 2.30 dollars.

CATALOGUES.

Catalogue No. 114: Zoologia. Pp. 60. (Paris: Paul Lechevalier.)

North America: a Catalogue of Books, Pamphlets and Engravings. (New Series, No. 2.) Pp. 136+4 plates. (London: Francis Edwards, Ltd.)

Diary of Societies.

FRIDAY, JUNE 7.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Summer Meeting), at 10 A.M.—F. J. Cleminson, M. Woodman, and W. S. T. Neville: Treatment of Carcinoma of the Œsophagus.—H. Barwell and Dr. J. A. Gibb: Inflammation in the Maxillary Antrum and Frontal Sinus.—At 5.—Dr. W. J. Horne: Cancer of the Vocal Cords.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish District) (at Town Hall, Hamilton), at 10.30 A.M.—W. H. Purdie: Hamilton, Historical and Municipal.—J. Robertson: Recent Road and Bridge Improvements in Lanarkshire.—P. A. Leitch: Notes on a Costing System.—T. M. Stephen: A 'Removal'.

GENETICAL SOCIETY (at Linnean Society) (Annual General Meeting), at 3.—Prof. D. E. Lancefield: The Genetics of *Drosophila obscura*.—Dr. C. Stern: Some Recent Work on *Drosophila*.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Dr. C. T. Onions: The Supplement.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. A. K. Wells, Dr. A. Brammall, and others: Discussion on The Value of Petrographic Character as a Criterion of Age.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. Leonard Woolley: Excavations at Ur, 1928–29.

SATURDAY, JUNE 8.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Unveiling at Wylam, at 2.30, of the George Stephenson Memorial Tablet, by the Lord Mayor of Newcastle-upon-Tyne.

MINING INSTITUTE OF SCOTLAND (at Y.M.C.A. Institute, Ayr), at 4.—S. Mavor: Recent Progress in Underground Conveying.

MONDAY, JUNE 10.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—W. E. Pretty: Pressure Shifts in Line Spectra of Gases.—A. S. M. Symons and J. Daley: The Zeeman Effect for the Arc Spectrum of Gold.—Dr. W. Jevons: The Band Spectrum of Lanthanum Monoxide.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—L. T. Scott: The Saura Oases and the Niger from Timbuktu to Jebba.

TUESDAY, JUNE 11.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. H. Dale: Some Chemical Factors in the Control of the Circulation (Croonian Lectures) (III.).

MINERALOGICAL SOCIETY, at 5.30.—Dr. G. T. Prior: The Meteoric Stone of Lake Brown, Western Australia.—E. J. Wayland: Bismutotantalite, a New Mineral from Uganda.—Dr. L. Hawkes: On a Partially Fused Quartz-felspar-rock and on Glomero-granular Texture.—Dr. F. Marshall: The Occurrence of a Mineral Hitherto Unrecognised in the Phonolites of Dunedin, New Zealand.—Füloppite, a New Hungarian Mineral of the Plagionite-semseyite Group: Exhibited by Dr. L. J. Spencer on behalf of I. de Finály and Dr. Sándor Koch.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—C. Coles: A Talk on Australian Birds, illustrated with slides by Members of the New South Wales Royal Zoological Gardens.—A. E. Ruxton and E. Schwarz: On Hybrid Hartebeests.—E. Schwarz: On the Local Races and Distribution of the Black-and-White Colobus Monkeys.—Sir Arthur Smith Woodward: The Upper Jurassic Ganoid Fish *Heterostrophus*.—Miss E. M. Brown: Notes on Hydrogen Ion Concentration, Excess Base, and Carbon Dioxide Pressure in Aquarium Waters.—J. W. Low: Contributions to the Development of the Pelvic Girdle. IV. The Pelvic Girdle and its Related Muscles in the Batrachian *Amphiuma means* Gardner.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. H. Oakden: Various Forms of Photomicrographical Apparatus.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Miss J. Gaultier de la Verindry: Folk Songs of Canada, Eskimo, Indian and French-Canadian.

WEDNESDAY, JUNE 12.

ROYAL SOCIETY OF MEDICINE (Surgery Section) (at Sheffield), at 2 and 6.

ROYAL METEOROLOGICAL SOCIETY (Summer Meeting) (at Rothamsted Experimental Station, Harpenden), at 2.15.

RESEARCH DEFENCE SOCIETY (at 11 Chandos Street, W.), at 3.—Prof. A. V. Hill: Enemies of Knowledge (Stephen Paget Memorial Lecture).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. Mackenzie Taylor: Base Exchange and its Bearing on the Formation of Coal and Petroleum.

EUGENICS SOCIETY (at Linnean Society), at 8.—W. T. J. Gun, Dr. B. Dunlop, and others: Does Industry need Dullards?

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—F. M. L. Sheffield: Chromosome Linkage in *Œnothera*, with Special Reference to Some F_1 Hybrids.—Grace Briscoe and Winifred Leyshon: Reciprocal Contraction of Antagonistic Muscles in Peripheral Preparations—using Flashing Neon Lamp Circuit for Excitation of Nerve.—W. S. Stiles: The Scattering Theory of the Effect of Glare on the Brightness Difference Threshold.—T. Moran: Critical Temperature of Freezing—Living Muscle.—E. C. Smith: The Formation of Lactic Acid in Muscles in the Frozen State.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Dr. T. J. I'a. Bromwich: The Application of Operational Methods to some Electrical Problems in Diffusion.—E. T. Copson and W. L. Ferrar: Notes on the Structure of Sequences (II.).—A. T. Price: Electromagnetic Induction in a Conducting Sphere.—C. T. Preece: Theorems stated by Ramanujan (X.).—Prof. G. N. Watson: Theorems stated by Ramanujan (XI.).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Prof. J. A. Gunn: Variations in Susceptibility to Drugs and Toxins.

OPTICAL SOCIETY (at Imperial College of Science), at 6.30.—Experiments, Demonstrations, and Exhibits, arranged by the Technical Optics Department of the Imperial College.—Exhibits of New Theodolites by Cooke, Troughton and Simms, Ltd., and E. R. Watts and Son, Ltd.—At 7.30.—Dr. W. M. Hampton: The Beam given by Dioptric Apparatus.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting in France (June 12–22).

FRIDAY, JUNE 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—T. P. Bhaskaran: The Number of Stars of Different Magnitude in the Hyderabad Astrographic Catalogue. Fifth Paper: Zone −21°.—Prof. E. W. Brown: The Planetary Theory with the True Longitude as Independent Variable.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Annual General Meeting), at 5.—E. Maddox: Demonstration of the Cheiroscope.—Miss M. Dobson: Velanoskiascopy, a Control in the Correction of Astigmatic Defects.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

SATURDAY, JUNE 15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.

PUBLIC LECTURES.

FRIDAY, JUNE 7.

KING'S COLLEGE at 5.30.—Prof. H. Wildon Carr: The Philosophy of Leibniz. (Succeeding Lectures on June 10, 12, 14, 17, and 19.)

CONFERENCES.

JUNE 5 TO 8.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Brighton).

Friday, June 7, at 11 A.M.—H. Dewey: The Denudation of the Weald.—Dr. G. P. Bidder: Death (Address).

At 12.—E. A. Martin: The Brighton Rubble Drift, and Cliff Formation.—A. Griffith: Some Sussex Birds and Insects.

At 8.—Reginald A. Smith: Early British Art (Public Lecture).

Saturday, June 8, at 10.30 A.M.—Prof. H. J. Fleure: Regional Survey Address.

At 11.30 A.M.—D. Edwards: Town and Regional Planning.

JUNE 11 TO 22.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting in France.

JUNE 13 AND 14.

INTERNATIONAL CONFERENCE ON LARGE HIGH-TENSION SUPPLY SYSTEMS (at 9 Avenue Hoche, Paris).

Thursday, June 13—*In Morning.*—Federal Railways (Switzerland): Recent Investigations and Tests on 132,000-volt lines.—M. Barrère: Results Obtained in the Operation of a 120,000-volt System.—P. V. Hunter and J. F. Watson: Certain Aspects of the High-tension Distribution Problem.—S. Fukunaka and Taizo Ueno: The Snow Trouble on a 154,000-volt Transmission Line, and its Remedy.—F. Courtoy: Organisation of Electricity Generation in Belgium.—G. R. Falkiner-Nuttal: Load-dispatching in Large Electric Power Systems in the United States.

In Afternoon.—A. Roncaldier: Parallel Operation.—A. Smouroff: Operation of Very Large, Interconnected Supply Systems.—U. Del Buono: Earthing the Neutral.—L. Maggi: Experience with an Earthed Neutral on the 130-kv. Systems of the Cisalpina Company.

Friday, June 14—*In Morning.*—C. I. Budeanu: Power Factor Improvement.—F. Rutgers: Simplified Graphical Representation of Active and Reactive Power in Vectorial Diagrams.—L. Gratzmuller: The Conservation of Reactive Power in Electric Systems.—A. Iliovici: Measurement of Electrical Energy and Power at Very High Voltages.—G. Renesson: Notes on the Measurement of Electrical Energy at High Voltages.—A. Barbagelata: Metering and Tariffs in Three-phase Supply.

In Afternoon.—L. C. Grant: Lightning and Surges on High-tension Transmission Lines.—R. O. Kapp: The Selective Protection of Transmission Lines.—P. Traverse: Investigation and Statistics on Surges in Transmission Systems.—F. W. Peek: Developments in the Control of Lightning.—Barbillion and Teszner: The Rôle of Condensers and Similar Devices in the Protection of Networks Against Surges: Theoretical and Experimental Study.—K. Gotoh and Matsunaga: Lightning and 154,000-volt Transmission Lines.—A. Iliovici: Selective Protection of Networks, Based on Unbalanced Currents, Voltages, and Power.—A. Tchernycheff: A New Method of Protection for Heavy-current Equipment.—M. Walty: Long-distance Communication in Electric Systems.—A. Tchernycheff: Special Apparatus for the Protection of Long-distance Communication Lines.—German Telephone Administration: Measurement of the Coefficient of Mutual Induction between Two Lines with an Earth Return.—T. N. Schulz: Standardisation of International Statistics in Regard to the Generation and Distribution of Electric Power.—P. Rieunier: Interconnexion of Systems Operating at Different Frequencies.—J. Kopeliowitch: The Use of an Ohmmeter as a Selective Relay.—L. Gratzmuller: Increasing the Number of Phases for a Supply to Mercury Converters, with a View to Reducing the Effect of Harmonics in a Distribution System.