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Europeans in the Indian Services.

THE story of the British servants of the Indian Government falls naturally into three periods. In the first period the Britisher (we cannot say Englishman because he was more often Scotch or Irish) usually gave up his native land, adopted India as his country, often took an Indian wife, and had a real chance of understanding the people he ruled. There were then few white women in India.

The transition to the second period was due to improved means of transport. The Britisher in the Indian Service no longer settled permanently in India, and he also normally brought with him a portion of European civilisation in the form of a wife. From the point of view of the welfare of India the change had a number of consequences. These British rulers were now birds of passage and thus had less opportunity and perhaps even less desire to understand the people. The introduction of European civilisation to India increased his separation from the people. The European wife disapproved of the earlier unions and their offspring, and the Eurasian, who might have continued to rank almost as high as the European if the first period had continued, now fell seriously in public estimation. Moreover, the presence of a wife and children was apt to affect the nerves of men who in their absence would have faced any situation with perfect equanimity; the Mutiny still casts a shadow. But the greatest weakness (a weakness shared with the first period) was the absence of contact between the educational and political sides of the Government. On the educational side the Government was teaching the people respect and admiration for democracy, while on its administrative side it remained a benevolent despotism. So apt a pupil as the Indian could not be expected to refrain from a demand for democratic institutions; which brings us to the third period.

The Morley-Minto reforms were not effectively in the direction of democratic government, and the third period dates from the Government of India Act of 1919 which gave effect to the Montague-Chelmsford reforms and introduced a degree of representative government under the system called "dyarchy." Under this system government activities fall into three classes :

1. Central services carried out for the whole of India by the Government of India.

2. Services entrusted to the local government acting on democratic lines, that is, entrusted to the governor acting on the advice of ministers responsible to a legislative council (called "transferred services").

3. Services entrusted to the local government on the old lines, the governor acting at his own discretion uncontrolled by the legislative council (called "reserved services").

The setting up of dyarchy inevitably raised certain problems, and it is the solutions to these problems offered in the report of the Lee Commission [1] that we have now to discuss. The problems were in effect (1) how should the staff required to carry out the transferred services be recruited and controlled, and (2) what proportion of Europeans should there be in the personnel of each of the services and how is the necessary number of suitable Europeans to be obtained. The principle of dyarchy gives the reply at once to the first question. The transferred services belong to the local government acting in its democratic capacity, that is to say, the officers are the servants of the legislative council, the orders of which they receive through the governor and ministers; and the appointment and control of the officers who carry out these duties must also be the affair of the governor and ministers acting for the legislative council. Accordingly the report proposes that for the education service, the agriculture service, the veterinary service, and the roads and bridges side of the engineering service, no new appointments should be made on the present terms on which officers hold from the Secretary of State, and that new services should be instituted to be recruited and controlled by the local governments.

Into the problem of the European recruits a number of considerations enter: the fall in the value of money, the question of security of tenure, the prospects of promotion, the comparison of the future and the past in regard to the spaciousness of the European's life, and the interest and importance of his work.

The proposals of the Commission in the matter of security and of the fall in the value of money are of a kind that should enable good men to undertake the work. The question of promotion depends on the relative merits of the European and the Indian in the services. The highest posts of all must be considered as outside the reckoning of the European because under the parliamentary system they will go more and more to Indians. Against this is to be set the fact that a smaller proportion of Europeans are to be recruited, so that the proportion of good posts per European is increased, and if they show themselves better men than their Indian colleagues their flow of promotion should be greater.

The greatest change is in the nature of the duties. The benevolent despot dislikes the change and thinks it will ruin India. He has ruled the Indians all his life on the assumption that they are children and he cannot now look on them otherwise. He is consequently out of place in the new system. Instead of him we need a man prepared to respect the Indian as an adult human being, to sympathise with his desire for parliamentary government, and to teach him to run the parliamentary machine. While this may be a position of less personal grandeur than the benevolent despot enjoyed, it is one of greater human interest, and for the right man it will provide a life fully as attractive as the old. It is also possible that by regarding the Indians as adults with human feeling and a certain degree of judgment, and not as children, the future European servants of the Government may escape from the shadow of the Mutiny which has so overhung their predecessors.

For the purpose of carrying out the recruitment and control of the services that are in the future to hold from the Secretary of State or the Government of India, a Public Service Commission is to be established. It will be both judicial and educational. Its judicial functions will be connected with the disciplinary control and protection of the services while its educational qualifications will come in in relation to recruitment. The appointment of this Commission is a necessary development and was in fact prescribed by the Government of India Act of 1919, and in addition to this central Public Service Commission each province will find it necessary to set up a similar body to manage the recruitment and control of the officers employed on transferred services. This is recognised by the Royal Commission, which states in paragraph 30 "we are aware that any proposal that a central Public Service Commission should be empowered to interfere on its own initiative in provincial administration would be regarded as violating the principle of provincial autonomy."

It is rightly recommended that the knowledge and experience of the Public Service Commission should be placed at the disposal of any local government that chooses to use it. It is highly desirable that the local governments should take advantage of this opportunity, but any self-respecting government will shy off if the attentions of the Public Service Commission are thrust upon it, and yet in paragraph 27(3) the Royal Commission recommends that the Public Service Commission should be the final authority for determining "the standards of qualification and the methods of examination" for the local government services. This recommendation clearly violates the principle of provincial autonomy and cannot possibly be put into force; and the very fact that it is recommended may determine the local governments to have nothing to do with the Public Service Commission.

The truth is that the Royal Commission has given little attention to the machinery of recruitment. Witness the illogical minute on the London Open Competitive Examination which has been thought worthy of publication. Witness also the recommendation that the upper limit of age for the Indian Civil

[1] Report of the Royal Commission on the Superior Civil Services in India, dated March 27, 1924.

Service should be twenty-four, because the universities prefer that age, and the statement that "it was a corollary of the decision to reduce the upper age limit to 23 years that the period of probation for recruits should be extended from one year to two"; the truth being that the basic decision was for two years' probation and reduction of the upper age limit to twenty-three an inevitable corollary. In this connexion we should have expected the Commission to take some account of the fact that a probation of two years is already in force for the Indian Civil Servants recruited in India.

In spite of these blemishes to which we have thought it necessary to direct attention, the fact remains that the Royal Commission has done sterling work towards making the government service attractive to the European. Its work is in the main excellent, and the blemishes can easily be removed.

Southern Nigerians.

Life in Southern Nigeria: the Magic, Beliefs and Customs of the Ibibio Tribe. By P. Amaury Talbot. Pp. xvi + 356 + 32 plates. (London: Macmillan and Co., Ltd., 1923.) 21*s.* net.

"ONLY by the good will of the black men will it ever be possible for more than the faintest idea of his complicated psychology to be grasped by the white; and could but the educated negro be brought to understand that he has infinitely more to gain than lose by recording every scrap of information concerning native customs and beliefs—omitting nothing and concealing nothing—such a book might be written as has never yet seen the light of day." This expression of opinion sums up Mr. Amaury Talbot's whole attitude towards the African. His latest book, "Life in Southern Nigeria," is written not only with knowledge and experience, but also in a spirit of sympathetic understanding. As a guide for future administrators the work is invaluable, combining as it does the results of scientific research with an appreciative knowledge of the beliefs and superstitions of an ancient people.

The Ibibio, of whom the author writes, are a little-known people living in the south-eastern part of Nigeria. They number, in all, more than a million, of whom some hundred and fifty thousand inhabit the Eket district. This is Mr. Amaury Talbot's description of them: "The Ibibio are typical negroes, thick set, with long arms, short trunks, medium-sized legs and feet broad and flat. Their language belongs to the Semi-Bantu group with many and strong affinities to the Sudanic tongue of their neighbours, the Ibo, with whom they have much in common." Although, as the author points out, the march of Western civilisation results in the younger members of the Ibibio becoming Christianised, many of the older generation still cling to beliefs and ways unchanged since the childhood of the world. "For them," he writes, "the commonplace does not exist, each object is tinged with wonder and mystery, while forces benevolent or malignant are to be felt on every hand."

According to Mr. Amaury Talbot there are two forces which influence the life of the Ibibio, the Ndemm (meaning fresh water) and the Ibokk (often translated by Juju as well as by medicine). The first of these forces dwells in or near rivers, pools, springs, and trees. They are gnomes, salamanders, dryads, etc., and are supposed to be male and female. The Ibokk are natural or elemental forces, which do not affect, or come into contact with, human beings until made to by a doctor or "wise" man. An interesting chapter is one on magic plays, where the author describes what may be called conjuring tricks. "A vast concourse of people gather together and a baby is brought into their midst. The child is thrown into a fu-fu mortar and beaten to pulp before the eyes of all the people. Three men are chosen to eat the babe, and when all is eaten, they begin to dance. After a while the central figure shakes his leg violently and from the thigh the child appears."

The idea that the soul of man or woman has the power to leave its human form and enter into that of its "affinity" is firmly held by these people. In proof of this the author relates the story of a Yoruba steward, who was caught by a crocodile one evening and dragged below into the river. After investigation it was found that the crocodile was supposed to contain the soul of a Juju man who, when angered against the Government, wreaked his vengeance on the officials. On this particular evening he was especially incensed against an official who had reported his evil deeds, and waited until he could have his revenge.

There are, according to Mr. Amaury Talbot, three secret societies of the Ibibio, the Egbo, Idiong, and Isong. Their initiatory ceremonies bear a strong resemblance to Freemasonry, and any non-member attending the ceremony would be punished severely. In an interesting chapter entitled social organisation and tabu, the author lays stress on the fact that slaves taken in war were most kindly treated, and in many cases allowed to marry into their masters' family. Amongst the food taboos the animals forbidden were snakes, monkeys, and lizards. In this chapter Mr. Amaury Talbot relates an experience he had whilst District Commissioner. Three of the head chiefs

of Ikotobo came to him one morning trembling with fear, and asked him if it were true that he was going to use tonite for the removal of some tree-trunks which were blocking a certain creek. Mr. Amaury Talbot assured them that no orders had been given to that effect, and demanded the cause of their fear. The answer was as follows: "Deep down in the waters of the creek are tiny houses such as ants make. Near these houses live fishes, with skins as black as our own. In these fishes are the souls of our ancestors, and for every fish you would kill one of our people would die."

Space does not allow one to quote the telling descriptions of bush fires, wide expanses of beautiful scenery, or vast pools of water given in this book. With regard to fire-worship, which still goes on, the author says: "In lands where such demonstrations of the power of fire are matters of constant occurrence, it is not to be wondered at that many rites of fire-worship should here still form part of the race. On a certain day in the wet season some towns, for instance, make two great bonfires, one on each side of the road. Then they gather their cattle, sheep, and goats into a herd and drive them between the walls of flame. This ceremony is said to destroy evil influences which might otherwise have caused sickness to fall upon the beasts during the year, and is also considered to act as a fecundative agent."

Upon realising the spirit in which the author has written this book, one is not surprised to find within its pages a graceful note of appreciation to two most valuable helpers. One is Mr. W. W. Eakin, of the Kwa Ibo Mission, and the other Etubom Nyung Ansa, better known by his English name, Chief Daniel Henshaw, Native Political Agent for the district. "He is," writes the author, "a Chief of pure blood and head of one of the seven ruling families of Calabar, where his ancestors were found in possession on the coming of the early traders."

Although Mr. Amaury Talbot fully realises the vast amount of work still to be accomplished in this part of West Africa, he is not discouraged; for he has an interesting theory regarding the solution of the problems before the administrators. "The darker aspects of many rites and beliefs may be attributed," he says, "in great part at least, to the shadow cast over the minds of the people by that dense tropical forest which covers such vast stretches of the West Coast, or by the mangrove swamps which surround low-lying lands. In open sun-lit country, like the wide plains of Northern Nigeria and the Sudan, the more revolting customs seem to be dying out, as was the case in Egypt with the cutting of the bush, and in Europe with the thinning of the great forests."

Climatology, Objective and Subjective.

(1) *Die Klimate der Erde: Grundriss der Klimakunde.* Von Prof. Dr. W. Köppen. Pp. x+369+8 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) 7*s.* 2*d.*

(2) *Die geopsychischen Erscheinungen: Wetter und Klima, Boden und Landschaft in ihrem Einfluss auf das Seelenleben.* Dargestellt von Prof. Dr. Willy Hellpach. Dritte, neubearbeitete Auflage. Pp. xx+531. (Leipzig: Wilhelm Engelmann, 1923.) 14*s.*

DEEPLY rooted in the human mind is the instinct to collect "specimens," to classify them and to arrange them in museums. Prof. Köppen is the exponent of this instinct in the domain of climatology; his specimens are data of temperature and rainfall. Some years ago he laid down his system of classification, and now he has completed and arranged his collection. "The Climates of the Earth" (1) is a handbook and guide to the Museum of Climatology. After a general introduction dealing along the usual lines with the objects and methods of the study of climate and the factors which govern the distribution of the climatic elements, we have a full account of the system of classification and notation, followed by generalised and then by more local descriptions of the different types. Finally there are sixty-nine pages of "specimens," namely, the mean and extreme temperatures, the rainfall, and in some cases the cloudiness and humidity for more than a thousand stations.

The results of such a systematic treatment are not difficult to foresee. There is an orderly development of the subject-matter which effects great economy of space. The ordinary political boundaries are ignored; Asia, for example, is treated under four headings, the tropical rain-belt, the dry region, the warm temperate rain area, and the boreal zone. The description is logically complete, and yet occupies only twenty-one pages. There is an even greater triumph of system in the frontispiece map, from which, knowing the notation, it is possible to read off the salient features of the climate of any part of the world with great ease and definiteness. On the other hand, when everything is subordinated to a system, there is no room for details which from the author's point of view are irrelevant. Climatic peculiarities which the visitor might regard as of some importance, such as the mistral of the Mediterranean, are either ignored or dismissed in a brief and colourless sentence. The use of the shorthand notation accentuates this impression of flatness; the statement that the climate of a large region is *Cfb* is no doubt complete and accurate, but until the interpretation becomes automatic, it is irritating

rather than inspiring, especially to the non-German reader who has to deal with contractions in a language not his own.

To sum up, the book gives a clear insight into the causes underlying the distribution of the main climatic features over the globe, and for this reason should be of great value to teachers, who can make use of the excellent arrangement of the material while filling in the details from other sources. The statistician will welcome it for the amount of information it conveys in a small space, but the ordinary reader will find it rather devoid of human interest and picturesque illustration. The author certainly has the courage of his convictions, for while there is a very complete index to the tables, except for the table of contents at the beginning there is no index to the text.

(2) "Geopsychical Phenomena" is a book of a very different stamp. The author is a nerve specialist, whose interest lies in the reaction of man to his natural environment, and from his medical experience he is able to write with great authority on the mechanism of these reactions. For him the basis of a classification of climates is not the mean temperature and rainfall, but the influence on human well-being, especially as exerted through the mind, either by means of the senses or by the general level of health induced. Climates (and also temporary weather conditions) are classed as enervating or bracing, and the instrument of research is not the thermometer or rain-gauge but the "weather man," who experiences these effects to the greatest degree. Thus the book is almost entirely subjective; it is of great human interest, as is proved by its having reached a third edition.

The chief sources of this interest are the vigorous detail and the fact that most of us have experienced in a greater or less degree the feelings described, for example, as accompanying the passage of a thunderstorm. But there is often a lack of definiteness, partly due to the subject-matter, which does not lend itself to exact treatment, and partly because the weather elements which the author regards as most important are not always those about which climatologists have most to tell us. Atmospheric electricity is credited with great effects, while the powers of solar radiation of various wave-lengths are well known, but more data about the distribution of these elements are required before the subject can be treated definitely. Hence the author is not entirely unjustified in blaming meteorologists for a certain inconclusiveness in some of his remarks. An experiment of even greater difficulty and, if possible, of even greater interest, is the attempt to measure the effects of that branch of the environment termed the landscape. The analysis mainly consists of a study of colour and form, and is certainly justified by its importance, but at the present stage a definite measure of the health-value of a landscape is scarcely to be expected.

It is interesting to note that even in such a subject as the "feel" of weather, numerical methods have obtained a foothold. Thus several formulæ are quoted which express the sultriness of the air numerically in terms of the temperature and humidity. None of them is quite successful, but they constitute a beginning. The author does not appear to be acquainted with recent British work on this and allied subjects, owing to difficulty in obtaining the necessary journals.

The book should be of great value to doctors, of interest to meteorologists and geographers, and it has also a strong appeal to the general reader, but only those who read German readily should attempt it. Once again we have to bewail the absence of an alphabetical index, and this time the omission is more serious.

The Teaching of Mathematics in France.

(1) *Cours complet de mathématiques spéciales.* Par Prof. J. Haag. Tome 3: Mécanique. Pp. viii + 190. (Paris: Gauthier-Villars et Cie, 1922.) 12 francs.

(2) *La Composition de mathématiques dans l'examen d'admission à l'École Polytechnique de* 1901 *à* 1921 Par F. Michel et M. Potron. Pp. xii + 452. (Paris: Gauthier-Villars et Cie, 1922.) 40 francs.

(3) *Dynamique des solides.* Par Dr. J. Reveille. (Encyclopédie de Mécanique appliquée.) Pp. 506 (Paris: J.-B. Baillière et fils, 1923.) 40 francs.

MATHEMATICAL teaching in Great Britain, at least in its more elementary stages, makes its appeal to the intuitive faculties of the pupil, and the mathematical and mechanical principles and methods are made as real and immediate as possible. If Prof. Haag's treatises are representative samples of French mathematical text-books, then they indicate that French mathematical teaching aims more at capturing the imagination of the learner and exercising his reasoning faculties in abstract terms. The professor's aim is to provide books for candidates who wish to enter the famous École Polytechnique and the École Normale Supérieure in Paris, and thus the book caters for the better class of pupils from the lycées or secondary schools. The atmosphere of the present book (1), with its emphasis on mechanical principles, is nevertheless highly abstract and theoretical. The treatment is interesting and possesses the elegance we expect from French writers. The author claims that "Un livre de mathématiques ne doit pas se lire comme un roman; plus il exige de travail et de

réflexion plus il est profitable." An English schoolboy would almost certainly read such a book like a novel, especially as in this "Cours" the examples are relegated to separate volumes. The author emphasises the importance of the examples and insists that the student should do a considerable number himself. French pupils can no doubt use such books: the English pupil needs something more concrete—but it would do any English student a considerable amount of good to read Prof. Haag's volume on mechanics, and study his interesting account of the principles of the subject.

This abstract and theoretical character is also to be found in the collection of mathematical questions set at the entrance examinations to the École Polytechnique, and issued with solutions by MM. Michel and Potron (2). The subjects included are algebra with analysis (*i.e.* calculus), trigonometry, geometry, and mechanics. Numerical examples are very rare, being limited apparently to the actual solution of equations. Even the questions on mechanics are very abstract and bear little relation to life, but they seem to test very well the fundamental principles. In each question the examiners suggest a topic or a mode of treatment, with a number of applications: the candidate's duty is to apply his knowledge to the series of questions on this one topic or method. We quote as an illustration *one* "composition" under the caption: Analytical Geometry and Mechanics.

I. On the logarithmic spiral $r = ae^{m\theta}$ take M_0, M defined by θ_0, θ.

(1) Find the centre of gravity G of the arc M_0M.
(2) Find the limiting position of G as M_0 tends towards the pole O.

II. When M_0 is at O, let the polar angle θ of M increase at the rate of 1 radian per second.

(1) Investigate the curve Γ which is the locus of G.
(2) Find completely the velocity V and acceleration A of G for any value of θ.

III. Instead of the spiral consider any curve C. The end of the arc $M_0M(=l)$ of this curve is supposed to move along C according to some given law in terms of the time. Given the centre of gravity G of the arc M_0M, the end M of the arc, the tangent MT at M, the length l of M_0M, the first two differential coefficients (l', l'') of l with respect to the time, find completely

(1) The velocity V of G.
(2) The acceleration A of G.

IV. In the particular case when the curve C consists of two rectilinear segments M_0O, OM

(1) Find the centre of gravity G of M_0M.
(2) Find the locus Γ of G as the segment OM assumes all possible positions round O as a pivot in the given plane.

This should be sufficient to indicate the style of the questions. The solutions are interesting and occasionally elegant.

(3) Dr. Reveille's book is a compromise between the abstract and the practical, as befits a volume forming part of the "Encyclopédie de Mécanique appliquée" issued under the direction of Prof. Lecornu. It combines in a really competent manner the theoretical and the industrial aspects of the subject of rigid dynamics. There is a good account of the motion of a body about a fixed axis, of general two-dimensional rigid dynamics, of the motion of a rigid body about a fixed point including both the Poinsot construction and the elliptic function solution, of the top, of a rigid body on a plane, and of the theory of gyroscopic motion. The whole forms a very good account of the most useful and important parts of rigid dynamics, including the method of Lagrange's Equations applied to holonomic and non-holonomic systems. At the same time the author discusses in considerable detail a large number of practical applications, such as the motion of millstones, the treadmill, the hoop, the bicycle, including looping the loop, and all kinds of gyroscopic methods, such as Foucault's experiment, Brennan's monorail, the motion of torpedoes, and various forms of gyroscopic compasses.

S. BRODETSKY.

Ambroise Paré.

Selections from the Works of Ambroise Paré. With Short Biography and Explanatory and Bibliographical Notes, by Dorothea Waley Singer. (Medical Classics Series.) Pp. iv+246. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 12*s.* 6*d.* net.

AMBROISE PARÉ (1510 ?–1590), although brought up as a barber surgeon, lived to become the founder of French surgery, one of its shining lights, and one of the greatest military surgeons of all time. He published a great deal during his lifetime, and his collected works appeared in many editions after his death. There must have been a very large number of copies of his works, and yet the earlier ones are excessively rare or even unobtainable in some of the largest medical libraries. Paré's experiences were bought practically in numerous campaigns, battles, and sieges in which he served various French kings against that stormy petrel of the sixteenth century, Charles V. Apart from his practical skill as a surgeon, Paré's name has been honoured in all subsequent ages as the ideal of an honest, modest man of a most humane disposition,

with an intense feeling of sympathy for the wounded soldier gashed by gunshot wounds or arrow-heads. His modesty is summed up in his motto, " Je le pansay et Dieu le guarit."

After the exhaustive work of Malgaigne and the charming work of Stephen Paget it is difficult to give a new view of Paré which is equal to theirs. Mrs. Singer set herself a difficult task, and in our judgment she has not been altogether successful. Her book consists of an introduction of 46 pages, in which the main facts of Paré's life and work are set out, while the rest of the book is a reprint of the English translation which Thomas Johnson made in 1634 from the Latin translation of Paré's " Œuvres " in 1582, by Paré's pupil Jacques Guillemeau. A comparison of the original French with Johnson's translation shows that Paré lost somewhat in his English garb, and it would probably have been better to replace the archaic Johnsonian phraseology by a modern English translation of the sections quoted.

A work like that which Mrs. Singer has attempted really requires co-operative editing in the present state of knowledge. A typical example may suffice. With reference to a case, described and cured by Paré, of a certain Guordon, Seigneur d'Achindon, Mrs. Singer gives a footnote (p. 68) which is almost certainly incorrect. She has been unable, she says, to trace Achindon, but there is no difficulty about this, as Auchindoun was the stronghold of the Huntly family, and still exists as a well-known ruin near Dufftown, N.B. The Guordon of Paré was almost certainly not the person suggested in Mrs. Singer's footnote, but Sir Adam Gordon of Auchindoun—the " Edom of Gordon " of Scottish ballad fame. This gay Gordon, after various adventures at Corrichie and elsewhere, burned the lady of Towie in her castle in 1574 and fled to France, where he was pursued by one of her kinsmen, Arthur Forbes. A most circumstantial account of Forbes's attempt to assassinate Auchindoun will be found in Robert Gordon's " History of the Earldom of Sutherland," 1830, p. 170, and this agrees exactly with the account of the Seigneur d'Achindon of Ambroise Paré. The matter we have referred to is perhaps trivial, but in works on medical history it is well to be accurate.

Our Bookshelf.

The Moon-Element: an Introduction to the Wonders of Selenium. By Dr. E. E. Fournier d'Albe. Pp. 166+8 plates.. (London: T. Fisher Unwin, Ltd., 1924.) 10*s.* 6*d.* net.

DR. FOURNIER D'ALBE'S book is chiefly a history of the optophone, the instrument for enabling the blind to read ordinary print. This history claims about one-third of the volume and deals in chronological order with the development of the device from its invention by Dr. Fournier in 1913 to its present form in which Messrs. Barr and Stroud, and, in particular, Dr. Archibald Barr of that firm, have collaborated. The long eighth chapter is a record of the pertinacity of the author for many years in the face of discouragement and opposition, and is almost a biography. Indeed, a not unsuitable title for the chapter, if not for the whole book, might be " The Triumph of the Optophone." It is natural enough that an author should write at length on the fruit of his own efforts. Here, in so small a volume, the effect has been to curtail too much what could have been written about other important applications of selenium. The optophone is the only instrument described in anything like detail. Most of the other selenium devices are referred to only briefly, and a few get no mention at all.

Dr. Fournier is not afraid to speculate; he does so whole-heartedly in more than one place. In the first chapter entitled " Electricity and Light," he gives himself especially free rein when he pictures " the two kinds of electricity as consisting of living beings of sub-atomic dimensions, divided, like the higher animalcules, into two sexes, and living their life on a scale of time and space removed a millionfold from the latter." The inclusion of this first chapter, much of which bears little relation to the scientific treatment of the subject in hand, definitely marks the book as popular rather than technical. Perhaps, indeed, this has been the purpose of the author, although it is not so defined in the preface. His enthusiasm for his subject sometimes displaces the impartiality proper to scientific description, and he would probably be prepared now to admit that his hypothetical and comprehensive condemnation of all selenium cells, save those of his own construction, as expressed in line 24, page 70, is scarcely worthy of an investigator of his own attainments.

In spite of its scientific defects the book is most eminently readable. Dr. Fournier's wide experience as an author in varied fields is a guarantee of that. He has a way with him in writing that grips the reader; the reviewer himself read the book from cover to cover in a single sitting. Dr. Fournier writes with the authority of a recognised expert, and if, as the title rather suggests, he has aimed at arousing the spirit of wondering interest among the general public, he will without doubt succeed. A. O. R.

Pulpwood and Wood Pulp in North America. By R. S. Kellogg. Pp. xii+273. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 20*s.*

THE manufacture of paper from wood pulp began on a commercial scale in 1854, as before that date the raw material ordinarily used was cotton and linen rags, esparto grass, straw, and hemp. The first process of making paper from timber was a purely mechanical one, by which the fibres of the wood, after being torn apart by grindstones under a stream of water, were transformed into so-called " mechanical " pulp, which is still the source of the cheaper kinds of paper. Tilghman in 1867 discovered the disintegrating action of sulphurous acid upon wood; and this formed the basis of the invention of the sulphite process, which was started commercially in Sweden

in 1874. The resulting product, "chemical" wood pulp, is used for the better classes of paper.

The wood pulp industry in a little more than half a century has grown to an enormous extent in Scandinavia, Germany, and North America. This is not to be wondered at, as the consumption of paper is increasing all over the world by leaps and bounds. In 1922 the paper used in the United States for newspapers alone amounted to 45 lb. per head of the population.

Mr. Kellogg gives a detailed account of the pulp industry as it is now carried on in Canada and in the United States. He describes the various processes of manufacture and the different species of woods employed, and gives statistics and charts of costs and production. He deals very fully with the important question of the timber supply now available in North America; and discusses the annual drain on the forests, due to felling for all purposes and loss by fire, insects, and disease. It is estimated that the timber in the United States at the present rate of consumption will last only for sixty-four years. The need for scientific forestry and better modes of protection is urgent in the extreme. The book is well illustrated with diagrams, maps, and reproductions of photographs, which depict forest scenes, pulp mills, and machinery. The view of a nursery in Canada, where five million seedling trees are raised annually, shows that some of the great lumber companies are at last taking active measures to replenish the areas that have been devastated by reckless felling and disastrous fires.

An Introduction to the Theory of Optics. By Sir Arthur Schuster. Third edition, revised and enlarged by the Author and Prof. John William Nicholson. Pp. xv + 397. (London: E. Arnold and Co., 1924.) 18*s*. net.

THERE is no need to set out here the merits of Sir Arthur Schuster's book on optics, and in describing the new edition, in which he has had the collaboration of Dr. J. W. Nicholson, we may confine ourselves to the novelties that have been introduced. These include descriptions of some of the newer optical instruments and processes, among them an excellent account of Michelson's method of measuring stellar diameters.

The main addition is in two chapters at the end, which deal with the quantum theory. In the first of them there is a good account of Bohr's theory of the hydrogen spectrum, which is followed by a short discussion of Planck's law of radiation. In this there is an unfortunate misprint, giving preference to Planck's second hypothesis over his first, instead of the other way about. We may also regret the absence of any mention of the thermodynamic principles which should serve as the basis of any discussion of radiation; indeed a detailed discussion of "black body radiation" would be a proper complement to the excellent descriptions of white light that are found earlier in the book. The account of the partition law is adequate, though we may confess a doubt whether a student coming fresh to the subject would find it convincing. However, this objection applies to nearly all presentations of the subject which approach it without a thorough consideration of statistical principles.

The last chapter deals with the dynamical theory of spectra. It follows mainly the work of Sommerfeld and his school, giving the three dimensional quantisation, fine structure, etc., and then Sommerfeld's construction of the formulæ of Rydberg and Ritz. It also contains an account of ionisation potentials and concludes with the dynamical theory of the separation of variables, the principle of adiabatic invariance and the correspondence principle which is applied to the Stark effect. Altogether the whole constitutes a good outline of many of the more recent optical applications of the quantum theory.

James Dewar, 1842–1923: a Friday Evening Lecture to the Members of the Royal Institution, on January 18, 1924. By Henry E. Armstrong. Pp. 32. (London: Ernest Benn, Ltd., 1924.) 1*s*. 6*d*. net.

EULOGY, whether spoken or written, makes greater demands upon judgment, knowledge, and taste than any literary task—so difficult is it, while maintaining equipoise between the elements that compose virility and virtue, to avoid transgression into adulation too fervid or into praise too faint. When eulogy relates, however, to a friend who has passed beyond mortal life, the task is to some writers made easier, for thoughts then spring from the depths in proverbial abundance, and there is more of reverence to steady the balance. It is in these circumstances that Prof. Armstrong pays tribute to his friend James Dewar. He extols the great philosopher in terms the substance of which is already familiar to those who early in the year followed the proceedings of the Royal Institution; but it is well that the discourse then so finely wrought in the rough, and now polished, and set in the gold of generous appreciation, should take this permanent form. Here and there some comparisons may be too vivid, here and there the detail may be weak, and the allusions may occasionally be inconsequent and in excess, but the work as a whole reveals with truth and justice the skill, genius, character, and nobility of purpose of James Dewar, in a manner to encourage and to inspire all who study it in a mood to respond. R. A.

Assyrian Medical Texts: from the Originals in the British Museum. By R. Campbell Thompson. Pp. vii + 107. (London: Oxford University Press, 1923.) 42*s*. net.

IN our issue of April 12, p. 529, we published a note on a reprint from the Proceedings of the Royal Society of Medicine by the same author on the same subject. The present work is a series of 107 plates containing the text of 660 cuneiform medical tablets for the most part previously unpublished. They are from the Royal Library of Ashurbanipal, now preserved in the British Museum, and date from the seventh century B.C. It is perhaps to be regretted that the preface is not given in greater detail, as otherwise the work is intelligible only to Assyriologists.

Bell's Card of Logarithms and Science Tables. 10 in. × 8½ in. (London: G. Bell and Sons, Ltd., 1924.) 2*s*. net per dozen.

THIS is a single card of convenient size for use in classrooms, giving four figure logarithms, trigonometrical tables for intervals of one degree, and a number of useful physical and chemical constants.

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.*]

Liquid Crystals—Soap Solutions and X-rays.

AMONGST the earliest examples of Lehmann's liquid crystals were the transparent double cones of ammonium oleate. MacLennan's work has shown that this transparent anisotropic state is common in soap solutions. The accompanying photograph (Fig. 1), taken by Mr. W. J. Elford in this laboratory at the suggestion of my colleague Mr. Piper and myself, shows the very striking appearance presented by these transparent solutions when examined in slightly convergent light between crossed Nicols. The transparent conic anisotropic liquid shown occurs in 2·5 weight normal potassium laurate at 45° C., magnification 200 diameters, and it exhibits very clearly the characteristic fan-like structure composed of focal lines.

A glance at the photograph shows the aptness of

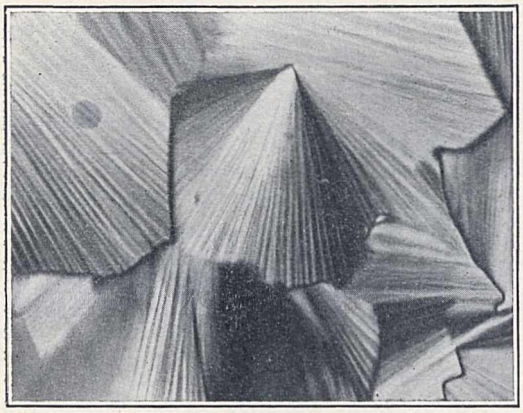

FIG. 1.—2.5 N potassium laurate. Transparent anisotropic plastic phase (40-50° C.). × 200 diameters.

Friedel's designation of this state of matter, namely, "liquide à conique," which he now proposes to supersede by the term smegmatic (smectique) in order to place soap curds in this class. We have found, however, that every aqueous soap such as potassium laurate may be prepared in each of the forms: hexagonal crystals, curd fibres, and anisotropic and isotropic liquids.

Piper and Grindley found a year ago that the curd fibres show an X-ray structure resembling Müller and Shearer's X-ray diagrams for crystals of fatty acid, whereas anisotropic liquids have given negative results. Following Friedel, they ascribed these curds to the "smegmatic condition." Friedel nevertheless expressly states that for any substance there can be only one "smegmatic" form, and that there are no discontinuities in a "smegmatic" specimen other than the apparent focal lines. Now curd fibres are discrete, and they differ greatly in almost every way from the conic anisotropic liquid soap illustrated in the accompanying photograph, which is seen to typify Friedel's "état smectique" or "liquide à conique." It is therefore evident that Friedel's attempt to classify opaque soap curds as "smegmatic" when that state is already filled by the transparent conic liquid soaps would disrupt his classification of liquid crystals and necessitate the *ad hoc* setting up of a new group within which to include such curds.

JAMES W. McBAIN.

University of Bristol.

Earth Tides and Ocean Tides.

I AM in entire sympathy with Mr. Lambert's plea in NATURE of June 21, p. 889, for further research on earth tides. It is much to be regretted that so little has hitherto been effected in that direction. I only wish our "far-flung" Empire had done its share in investigating geophysical problems connected with the earth's crust. I fancy, however, that the horizontal pendulum would be more easily and cheaply installed in outlying stations than the interferometer apparatus of Michelson and Gale. The Milne-Shaw seismometer can be adapted for the purpose by the addition of a stationary mirror tracing a reference line on the record.

Mr. Lambert refers to the "greater apparent rigidity in the prime vertical than in the meridian . . . in various places near the Baltic Sea." This presumably applies to the horizontal pendulum observations at Potsdam and Dorpat (in Esthonia). He goes on to say that "when various ingenious explanations of this peculiarity were found to be untenable, it came finally to be accepted that the true explanation lay in the effect of the oceanic tides."

At Potsdam, where the inequality of the rigidity in different directions is much greater than at Dorpat, the direction of maximum rigidity is apparently not due east and west but about 8° north of west and south of east. This is approximately parallel to the strike of the later foldings in the older rocks to the south and no doubt also of those covered by the Quaternary deposits in the neighbourhood of Potsdam itself. This folding probably extends some miles down in the earth's crust and must diminish the rigidity in a direction at right angles to its strike. I fail to see why this explanation is untenable.

It would be interesting to ascertain how rigidity varies with direction in the neighbourhood of lines of north and south folding.

JOHN W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7.
June 28.

The Structure of Molecules in relation to their Optical Anisotropy.

As is well known, the light scattered transversely when traversing a column of gas or vapour is not completely polarised, the defect of polarisation depending on the nature of the substance. The explanation of this phenomenon as developed by the late Lord Rayleigh, Born, Sir J. J. Thomson and others is that the molecules which scatter the light are optically anisotropic, that is, have different refractivities in different directions, and are oriented arbitrarily in space. From the point of view of dispersion-theory, the interpretation usually given is that the electrons responsible for the refraction of light are anisotropically bound in the molecule.

This way of regarding the matter, though perhaps not formally incorrect, does not hold out much hope of progress in interpreting the experimental results, owing to the scantiness of our knowledge regarding the manner in which the dispersion-electrons are bound in complex molecules. Recently, under the writer's direction, a series of accurate measurements have been made in his laboratory of the scattering of light in some thirty different gases and vapours by Mr. A. S. Ganesan, and in more than sixty different transparent liquids (chiefly organic compounds) by Mr. S. Krishnan, and the empirical knowledge thus accumulated of the relation between light-scattering and chemical constitution emphasised the unsatisfactoriness of the position of the subject on the theoretical side. Thus,

for example, the observations showed that molecules containing elongated chains of CH_2 groups and therefore highly unsymmetrical in shape are, optically, much more nearly *isotropic* than benzene, toluene and other compounds of the aromatic series.

These and other results stand in need of explanation, and it is the purpose of this note briefly to indicate a method of dealing with the matter which is at least a useful working hypothesis. The suggestion is that the optical anisotropy of the molecule is due, in the main, to the mutual influence of the electric doublets induced by the external field in its constituent atoms, the latter, individually, being themselves more or less completely isotropic. A similar idea has recently been used very successfully by W. L. Bragg to explain the doubly-refractive character of substances in the solid crystalline state, *e.g.* calcite and aragonite.

Following up the working hypothesis indicated, Dr. K. R. Ramanathan has, at the suggestion of the writer, calculated the degree of optical anisotropy to be expected theoretically for the molecules of a number of substances in the gaseous state and obtained most encouraging results. The fullest test of the theory will be that furnished by the series of organic vapours studied; the detailed calculations necessary for this purpose have been undertaken. Qualitatively, it is not difficult to see that the closer packing of the atoms in the benzene rings compared with that in the chain compounds would enhance their mutual influence, and that, consequently, the greater anisotropy exhibited by the compounds of the aromatic series is what we should expect on the hypothesis suggested. C. V. RAMAN.

s.s. *Kaisar-i-Hind*, near Marseilles,
June 19.

Emission of Volcanic Gases.

I TOO have been shown the effect described by Prof. Conway in NATURE of June 21, p. 891, at the Solfatara, near Naples. I was inclined to believe in its objective reality, but was not sure. I write to suggest that some scientific man who is taking his holiday in that neighbourhood should carry a camera with him, and obtain a photograph before, and another after, the torch has been applied to the vent. In that way I think it would be easy to decide objectively whether the distant vents are affected or not. RAYLEIGH.

69 Cadogan Square, S.W.1, June 21.

I WAS glad to see Prof. Conway's letter on the "Emission of Volcanic Gases" in NATURE of June 21, in which he directs attention to the remarkable phenomenon observed at the volcano of Solfatara when a lighted torch is waved over one of the vent-holes in the crater.

I was also present at Naples on the occasion mentioned, and, along with some friends, took the opportunity of visiting Solfatara, where we observed the phenomenon described by Prof. Conway.

The increase in the amount of fumes emitted was quite unmistakable. A. A. ROBB.

Cambridge, June 22.

I HAVE seen repeatedly during the last thirty-eight years the evocation of gas at Solfatara, described by Prof. Conway in NATURE of June 21, p. 891. The phenomenon is certainly not subjective, neither is it trickery. I venture to offer the hypothesis that, under the floor of the crater, deep caverns are filled with volcanic gases, the equilibrium of which is unstable to a small change in atmospheric pressure, such a change being effected when the air above a group of crevices is heated by the torch. The crevices must be connected with the deep reservoir by passages, and the gas must be generated into the reservoir at a pressure exceeding atmospheric pressure by the pressure due to the vertical column of heavy gas in the passages, added to the pressure necessary to produce the flow of the gas through their length.

Instability is due to the fact that gas drawn up to the torch is hot gas, which therefore rarefies the air more, and so draws up more and hotter gas; and further, that the torch drawing gas from the passages to the crevice must draw also gas from the deep reservoir to the passages and from the lower part of the passages to their upper part. In all cases the gas passes from deeper and therefore hotter strata to higher and therefore cooler strata—so that the whole gaseous column becomes warmer and therefore lighter than it was before. Consequently the weight of the column no longer equipoises the pressure in the deep reservoir, and this therefore forces out gas by the passages through every aperture, the uprush further heating and lightening the column, and therefore renewing itself, until a second equilibrium is reached at a lower reservoir pressure plus a more rapid upward flow of gas. Eventual slackening of this flow and reversal of the steps must be brought about by the cooling of the deep chambers producing a lower pressure of generation; this reduces the rate of flow and therefore increases the time which is passed by the column in the cooler strata. The column therefore becomes cooler and heavier and requires higher pressure in the reservoir to lift it, while the escaping gas is cooler and the rarefaction of the external air lessens. Each consequence reinforces its cause, until the *status quo ante* is reached with the external atmosphere at its original temperature and pressure.

Evidence for the existence of large unstable gaseous reservoirs has lately appeared to me to concern not only the colliery engineer, but also the biologist. It seems possible that some of H. Munro Fox's interesting lunar cycles in life-histories, especially of marine organisms,[1] might conceivably be explained by the earth-wave of spring-tides distorting the walls of subterranean caverns filled with gas, and so releasing an importantly greater quantity of carbon dioxide, etc., at the new and full moon. Thus the constitution of the sea-water in their neighbourhood would have a fortnightly and monthly chemical periodicity which would produce a physiological periodicity in inhabitants sensitive to those constituents.

GEO. P. BIDDER.

Cambridge, June 22.

PROF. CONWAY'S letter in NATURE of June 21 again directs attention to this remarkable phenomenon. Since my former visit, my daughter, Ruth Place, has visited the volcano for further investigation, and we suggest that the sudden emanation of visible gases and vapours may be the effect of ionisation started by the torch flame.

There may be another explanation. The whole system must be charged with superheated aqueous vapour, the temperature varying from 99° C. to 161° C., as observed by Prof. Mercalli, the lower temperature obviously that taken near the surface. When the organic substance, namely, resin torch, or even a bunch of brushwood, paper, etc., is burnt, it will produce water which will condense the hot aqueous vapour and form fog, and so will quickly influence the whole zone and become visible over an extensive range of ground. JOHN PLACE.

16 The Avenue, Beckenham, Kent.
June 30.

[1] At Naples *Nereis dumerilii* and *Dictyota dichotoma*, both breeding fortnightly (Proc. Roy. Soc., vol. 95, p. 544).—Note that there are effervescent hot springs known to bathers in the sea at Bagnoli, near the Solfatara.

Explanation of Abnormal Low Voltage Arcs.

IT is well established that arcs in gases or vapours may be maintained at voltages as low as their ionising potentials, or, in cases where cumulative ionisation is possible, as low as their radiating potentials, provided a hot cathode is used as a source of electrons to stimulate the arc. Considerable discussion has arisen over certain cases in which arcs have been maintained at still lower voltages,[1] since at such voltages the electrons are known not to effect partial or complete ionisation of molecules with which they collide.

Recently Bar, v. Laue and Meyer [2] and, independently, the present writers,[3] have shown that this may be accounted for by the existence of oscillations the peak voltage of which always exceeds the lowest radiating potential of the gas. An experimental and theoretical study of these oscillations has shown them to be in the nature of current interruptions occasioned by the rise in current and consequent drop in voltage occurring when the ionisation is sufficient to create a positive space charge around the filament. Under such conditions there is nothing to prevent a rise in current to its saturation value. With such a rise, the increased potential drop in the series resistance reduces the voltage across the arc. If this reduction takes the voltage to a value below the lowest critical potential of the gas, the current can be maintained only so long as the supply of previously excited atoms persists, after which the current decreases, the voltage rises, and the cycle is repeated. Reactance in the circuit is not, as believed by Bar, v. Laue and Meyer, essential to the oscillations, though it does affect the wave form.

The above phenomenon does not explain all cases of abnormal low voltage arcs, however, for we have maintained arcs in helium, mercury vapour and argon, without oscillations, at voltages well below the lowest critical voltages of the gases. Also Holst and Osterhuis [4] have reported steady arcs in argon at 3·5 volts and neon at 7·5 volts, whereas the lowest critical potentials of these gases are 11·5 and 16·7 volts respectively. To account for this, these authors have proposed a rather elaborate theory of progressive ionisation. The following experiments, however, explain entirely these abnormally low voltages simply on the basis of well-known phenomena.

A short hot-filament cathode and a sheet nickel anode were placed about 1 cm. apart, and a 3 mm. length of 1 mil wire projecting from a glass stem was introduced as an exploring electrode in a bulb filled with pure argon at 2 mm. pressure. This electrode was used according to Langmuir's recent method,[5] and was movable to different points in the discharge by a flexible copper-to-glass seal.

It was found that the arc could easily be maintained at an applied voltage of about 4 volts, without oscillations. Under these conditions, however, *the gas near the filament was found to be at a potential of about 11·5 volts above that of the filament*, and there was an electric field in the direction reverse to the applied field throughout most of the space between the electrodes. Furthermore, the concentration of ions, either positive or negative, was found to decrease from about 100×10^{10} per cc. near the cathode to about 2×10^{10} per cc. near the anode. The average kinetic energy of the electrons outside the region of the cathode drop was found to vary from 2 to 4, in equivalent volts. Analogous results were found in a mercury arc, operating at about 3·5 volts.

Evidently there is *always* a sufficient cathode drop to produce ionisation. If the ionisation is intense, positive as well as negative ions move toward the anode, and at approximately equal rates. To cause this, the reverse electric field, caused by difference in rates of diffusion of electrons and positive ions, takes such a value as to cause the two types of ions to move toward the anode at nearly equal rates. It is easily shown that the number of ions of either sign is at least a million times greater than the excess of one kind over the other, except in the region of the cathode drop.

A fuller treatment of this problem and its significance in the Geissler tube discharge will soon be published.

We are indebted to Dr. Irving Langmuir for suggesting this general line of explanation of the abnormal arc.

KARL T. COMPTON.
CARL H. ECKART.

Princeton University.

[1] Compton, Lilly and Olmstead, *Phys. Rev.*, 4, p. 282, 1920; A. C. Davies, Proc. Roy. Soc., A, 100, p. 599, 1922.
[2] *Zeits. f. Phys.* 20, p. 83, 1923.
[3] *Science*, 59, p. 166, 1923.
[4] *Physica*, 4, p. 42, 1924.
[5] *Gen. Elec. Rev.*, p. 731, Nov. 1923.

De Broglie's Theory of the Quantum and the Doppler Principle.

L. DE BROGLIE (*Phil. Mag.*, Feb. 1924) has recently suggested a theory of the quantum in which the quantum is supposed to be a corpuscle of exceedingly small rest mass M which moves with a velocity βc, where β is less than unity by an exceedingly small amount. The momentum of such a corpuscle is $M\beta c/\sqrt{1-\beta^2}$, and is equal to that of the light quantum $h\nu/c$. Since β is so nearly unity, the momentum may be written as $Mc/\sqrt{1-\beta^2}$. Different values of the frequency ν are explained as being due to different values of β.

Let us suppose that an atom is moving towards the observer with a velocity $\beta_1 c$, and that while moving with this velocity the atom ejects a quantum in the direction of the observer, the frequency of the quantum being ν_0 and its velocity $\beta_0 c$ relative to an observer on the atom. The momentum of the quantum relative to the atom is then $h\nu_0/c = Mc/\sqrt{1-\beta_0^2}$. By applying the relativity theorem of the addition of velocities, we have that, if βc is the velocity of the quantum corpuscle relative to the stationary observer,

$$\beta c = (\beta_0 + \beta_1)c/(1 + \beta_0\beta_1).$$

Hence

$$1 - \beta^2 = \frac{(1-\beta_0^2)(1-\beta_1^2)}{(1+\beta_0\beta_1)^2}.$$

Remembering that β_0 very nearly equals unity, and assuming that β_1 is small, we have

$$1 - \beta^2 = (1-\beta_0^2)(1-\beta_1)^2.$$

Hence if ν is the frequency relative to the stationary observer we have

$$h\nu/c = Mc/\sqrt{1-\beta^2} = Mc/(1-\beta_1)\sqrt{1-\beta_0^2} = h\nu_0/c(1-\beta_1).$$

If now we put $\beta_1 = v/c$, where v is the velocity of the atom relative to the stationary observer, we have

$$\nu = \nu_0 c/(c-v),$$

which is the equation expressing the Doppler principle when the velocity v of the radiating atom is small compared with c.

G. E. M. JAUNCEY.
Washington University,
St. Louis, Mo., May 23.

THE result obtained by Mr. Jauncey seems to be quite correct, and I already knew that it was possible to explain all the forms of Doppler effect by means of my "light quantum" conception.

By studying the collision of a moving electron with a light quantum, I have also obtained a formula for the change of frequency which involves both the Doppler effect and the Compton effect.

In a recent number of the *Phil. Mag.* (May 1924) Mr. William Anderson has stated a curious and perhaps not very probable consequence of my views,

I think that the *isolated* quantum of radiant energy can only be considered in radiations of very high frequency (when Wien's law is valuable), but that for radiations of mean or low frequencies we must conceive a sort of aggregation of light quanta. This idea suggested by the form of Planck's law would perhaps allow us to imagine a transition between light quanta and electromagnetic theory and to avoid Mr. Anderson's conclusion.

June 14. LOUIS DE BROGLIE.

Cell Inclusions in the Gametogenesis of Scorpions.

SINCE last winter I have been engaged on the study of cell-inclusions in the gametogenesis of scorpions, and it was, therefore, with some interest that I read the note of Profs. D. R. Bhattacharya and J. B. Gatenby on the spermatogenesis of an Indian scorpion (Palamnæus) published in NATURE, June 14.

I have studied mitochondria in the spermatogenesis of *Palamnæus fulvipes madraspatensis*, and can confirm the following statements of the writers :

(1) " The mitochondria are sorted out whole during the maturation stages." This is true of both the meiotic divisions.

(2) " The number of mitochondria varies in the spermatid."

In *Palamnæus fulvipes madraspatensis* the number varies from four to thirteen.

I am, however, unable to support the statement that " the mitochondria form the sperm tail directly. . . ." During a certain stage in spermateleosis the mitochondria are grouped together at the base of the elongated nucleus. To a large extent they lose their individuality and form a curious oval body—the mitosome—which stains characteristically with crystal violet, Altman's acid fuchsin and iron hæmatoxylin. I have not been able to detect the mitochondria after this stage. Nor have I seen them at any stage descending down the axial filament.

I may here add a note on the mitochondria of the oocyte of the same species. They are remarkably different in their reaction to osmic acid from those of the male germ cells. There is no case on record where the mitochondria are blackened by chrome-osmium alone. Where they are blackened, it is only after prolonged osmication (Kopsch). But the mitochondria in the oocyte are intensely blackened by chrome-osmium alone in ten hours. They are even preserved and blackened by Fleming-with-acetic acid. They can be decolorised by turpentine, but subsequent staining is impossible. They are completely destroyed by Bouin's fluid. These facts undoubtedly suggest the presence of a large amount of unsaturated fat in the mitochondria.

The Golgi apparatus in the oocyte of the same species consists of rods and crescents distributed in patches.

I hope to publish in due course a paper on the cell inclusions in the gametogenesis of Palamnæus (Madras), *Buthus judaicus* and *Heterometrus maurus* (Palestine), and *Euscorpius napoli* (Naples).

VISHWA NATH.

Zoological Laboratory, Cambridge,
June 20.

Art-Forms in Nature.

PERMIT me to thank Mr. Edward Heron-Allen for the very generous reference to my work published in his review of Haeckel's " Kunstformen der Natur " (NATURE, June 14, p. 847). Mr. Heron-Allen says: " A law only approximates to the facts, and every time we use it we have to make appropriate additions and corrections ; the real value of deviations is not that they make it necessary to discard a theory, but that they enlarge our laws and thereby advance our knowledge." This sentence formed part of an appreciation of my book, " The Curves of Life," which was published in 1914. With your permission I will quote a short passage from this book which gives an excellent example of the process mentioned, an example which in 1924 we can all read with a startling verification in our minds.

" The principle enunciated by Newton," I wrote on pp. 429 and 430, " may ' simplify ' the phenomena of our solar system sufficiently to enable us to talk about the movements of the earth and the celestial bodies. But that simplicity, we may feel sure, is only apparent. Newton himself, as far as I am aware, never ventured to suggest any ' cause ' for his great principle. We may well consider that its value as a working hypothesis outweighs the possibilities of its inexactness. But we must be equally prepared to realise that it may not fit all the facts which future science may discover. It is, in H. Poincaré's admirable phrase, *une règle d'action qui réussit* ; or, in other words, we have added (1914) so few phenomena of real importance to those known by Newton that the basis furnished by his ' law ' has not yet been disintegrated. But it is easily conceivable that a broader foundation will be needed, even in the present century ; and we need have no fear that men of science will shrink from the endeavour to provide it. The sterile reprobation of Auguste Comte (who was obsessed by sociological ideas of ' Order ') has long ago become inoperative."

These lines were written ten years ago, and I freely admit that logic had more to do than special knowledge with a prophecy which Einstein was so soon and so brilliantly to fulfil. THEODORE A. COOK.

Savile Club, 107 Piccadilly, W.
June 19.

The Oogenesis of Lithobius.

THE oogenesis of the Arthropoda is the least well understood, because it has presented considerable technical difficulties. In this country Hogben has investigated successfully the oogenesis of dragonflies, and has shown that the nucleolus takes important direct part in the production of the yolk spheres.

The oogenesis of Lithobius appears to be much like that of Hogben's examples, and is probably general for Arthropoda. Yolk formation is from nucleolar extrusion, of which two phases can be distinguished ; first, an early extrusion of particles budded off from the large central nucleolus, which retains its individuality, and, secondly, an extrusion of particles derived from the fragmentation of this nucleolus. These particles multiply both in the nucleus and in the cytoplasm. The fate of the first nucleolar extrusions has not been determined, but the later extrusions enlarge after proliferation to form the definitive yolk spheres. The Golgi apparatus behaves in the usual way, being excentric and juxta-nuclear in the youngest oocytes, then spreading out through the cell, and breaking eventually into very fine grains. The mitochondria are diffuse in the earliest stages, then become concentrated to a cloud near the nucleus ; this breaks up into a number of clusters, some of which become active centres of proliferation. These form curious round mitochondrial bodies, which later fragment, the mitochondria passing out to become evenly distributed through the cytoplasm. The clouds which did not take part in the rapid proliferation also become scattered at the same time.

A full account of the oogenesis will be published later. S. D. KING.

Zoological Department,
Trinity College, Dublin.

Artificial Daylight.

By Dr. L. C. MARTIN.

THE apparently simple question "What is Daylight?" raises at once a host of supplementary questions which are not easy to answer, and a little consideration shows that "daylight" is a word of somewhat indefinite meaning. The paper on which the present article is being written is illuminated by light from a north window. The sky is blue, but flecked with white clouds reflecting winter sunlight. A proportion of the light is, however, coming from the walls of an opposite house, and since this house is flanked by green trees and shrubs, they are also contributing their share of reflected light. A spectrophotometric examination of the light would doubtless reveal a somewhat irregular spectral distribution of energy, varying from minute to minute, although the eye registers no marked change in the appearance of the paper. Even after the drastic step of drawing the blinds and switching on the electric light, the appearance will scarcely indicate the tremendous alteration in the nature of the light, at any rate when the eye has been accustomed to the changed conditions. It is not until some effect of simultaneous contrast brings the artificial light into comparison with daylight that the difference between the two is revealed.

It is quite clear that it is useless to attempt to copy the heterogeneous radiation described above; therefore it is necessary to study the distribution of energy in the spectrum for summer sunlight and the light from a blue sky, and to see how far the means at present available will allow the production of radiation with similar characteristics. Some suitable compromise can then be decided upon. Fig. 1 shows, reduced to a common ordinate at 0·59μ, the *relative* distribution of energy in the spectrum for blue-sky light, summer sunlight, and electric light (gas-filled incandescent lamp). The gas-filled lamp radiates, as indicated by experiment, in a manner similar to a perfect radiator (the black body of the physicist) at a temperature of 2800° C. By extrapolating from experimental results, it is found that the sun radiates like a perfect radiator at about 5000° C., a temperature unfortunately quite unattainable at present in any usual and practical terrestrial source of light. It is only in intense electric discharges that such temperatures can be attained experimentally.

Amongst the special means of light production the Moore vacuum tube must be mentioned. The discharge from a small transformer passes through rarefied carbon dioxide at a pressure of about 0·1 mm., the tubes being of considerable length when used for industrial lighting. Luckiesh states that the light is a "good approximation to average daylight." Since the spectrum consists of bands, however, and is by no means continuous, this light is apt to prove untrustworthy for colour matching purposes, more especially in dealing with substances possessing bright narrow bands in the spectrum of their transmitted or reflected light.

Phosphorescence and allied effects are extremely efficient in regard to the energy required in producing a given amount of light, but under present conditions the utilisation of the phenomena for commercial light production is not practicable.

We turn, then, to consider the means of modifying the energy distribution in the spectra of ordinary sources, and before proceeding to the better known methods, two useful laboratory devices may be mentioned. Priest finds that by passing the light through a system of polarising prisms and quartz plates cut perpendicular to the axis, the spectrum of such a source as the gas-filled tungsten lamp can be modified to an equivalent of that from a black body radiating at 5000° C., and moreover, the apparent temperature of the equivalent radiator can be controlled over a wide range. The Arons chromoscope is convenient for the purpose. Another method of interest is the spectrum template of Abney and Ives, in which the radiation from the source is first dispersed

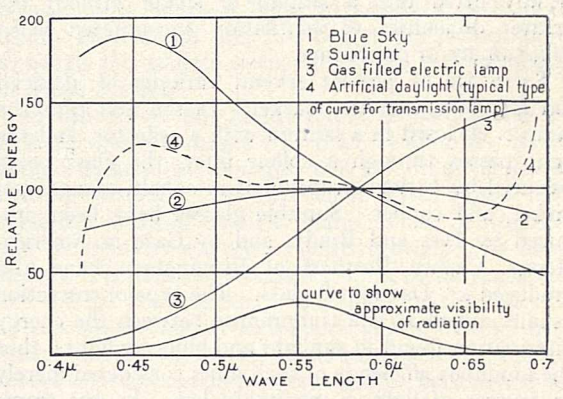

FIG. 1.—Relative distribution of energy in spectra of light sources.

into a spectrum and then recombined. In the plane of the spectrum a sector rotates, and one of the lines bounding the angular opening of the sector is curved in such a way that the effective angular aperture varies so as to be greatest in the blue and least in the red regions of the spectrum. In fact the apparent energy distribution in the spectrum of the reconstituted light can be made to follow any prescribed law.

It will be apparent, however, that the two foregoing methods are wasteful in so far as their action depends on the mere elimination of the excess energy of the longer wave-lengths.

Apart from consideration of energy distribution, however, the two methods above are quite impossible for lighting purposes, and therefore the aid of selectively transmitting or reflecting light filters or reflectors has to be employed, this expedient being suggested by Mr. A. P. Trotter some thirty years ago or so. In 1899 Dufton and Gardner produced a filter for correcting the light from the carbon arc. Though this light has an energy distribution which comes almost as near to sunlight as any artificial light (the temperature of the carbon arc is 3500° C. to 4000° C.), the flame of the arc gives an excess of violet radiation from the well-known cyanogen bands, and hence the radiation needs a special type of correction. Dufton and Gardner's glass was coloured blue-green by means of copper, and a trace of uranium gave the property of filtering out the excess of violet from the arc-light.

Since that time several types of colour filter made of

special glass, or glass in series with dyed gelatin films, have been introduced for the correction of the light from other artificial sources, namely, ordinary metal filament electric lamps, gas-filled electric lamps, and incandescent gas lamps. Lamps employing coloured reflectors have also been introduced. The gas-filled electric lamps work at a higher temperature than those of the ordinary metal filament type, and consequently the correction required to produce artificial sunlight is less drastic in the first case. The correction for an incandescent gas mantle is even less since the spectrum of the radiation is particularly rich in the shorter wavelengths as compared with the radiation from a "black body" at the same temperature.

On the whole, experience has shown that the gas-filled lamp lends itself most readily to the present purpose, and practically all the modern lamps start with this light mainly because gas-filled lamps can be readily fitted into a lantern or shade without the greater difficulties of ventilation encountered when using an arc or gas burner.

There are at present several varieties of artificial daylight lamps on the market. In the first type the lamp is enclosed in a lantern with a reflector, and the light passes through a colour filter, the glass being coloured by various proportions of cobalt, manganese, nickel, and copper. Suitable glasses have been produced by Ives and Brady, and by Gaze in America. Messrs. Chance Brothers of Birmingham have also produced a "Daylight" glass. The type of correction usually aimed at is a compromise between the energy distribution found in sunlight and blue-sky light; thus the luminous efficiency of such units considered merely as sources of light is inevitably low. In one transmission lamp recently examined by the writer the overall efficiency was only 8 per cent. as compared with the unshaded lamp, but this was employing an ordinary metal filament bulb. If a gas-filled bulb had been employed the efficiency would probably have been much greater, perhaps 12-15 per cent.; a great deal depends on the reflector, which can, if well designed, produce a considerable concentration of light, thereby counteracting the unavoidable disadvantage of the loss of light in the filter.

The glasses employed for the filters often show some deviation from the desirable smooth transmission curve. In the unit due to Lamplough a small excess of green transmitted by one blue filter is compensated by the provision of a second filter of glass slightly coloured purple by the use of gold. The purple filter absorbs the excess of green and the quality of the light is greatly improved.

A second type of lamp (the Sheringham Daylight) employs the device of reflecting the light from a surface coloured with patches of blue, green, and red or yellow pigments in definite proportions of area. The light is completely diffused, and this is a considerable advantage when imitating the effects of actual daylight. Furthermore, the energy distribution of the reflected light can be made very "smooth," although it is difficult, just as before, to secure drastic correction without undue loss of energy. The method of making a spectro-photometric comparison between natural and artificial daylight has been described by Mr. P. R. Ord in the *Illuminating Engineer* for July 1923, but there is at present very little available information on the relative performances in energy distribution and luminous efficiency of the various lamps.

The actual correction attained in all these lamps is good over the brightest part of the visible spectrum between 0·45μ and 0·65μ. At the violet end the radiation is very deficient in violet, and at the extreme red end practically all the commercial units give far too much energy (see Fig. 1). The fact that these defects do not destroy the ordinary usefulness of the lamps is owing solely to the low visibility of the radiations corresponding to extreme ends of the spectrum, as shown by the lowest curve in Fig. 1. Occasionally the error is made manifest by some material with a low reflection through most of the spectrum and a large reflection at the red end. The "artificial daylight" may then produce a different appearance in such a substance as compared with daylight itself, but on the other hand, such materials vary greatly in appearance under the variations of daylight.

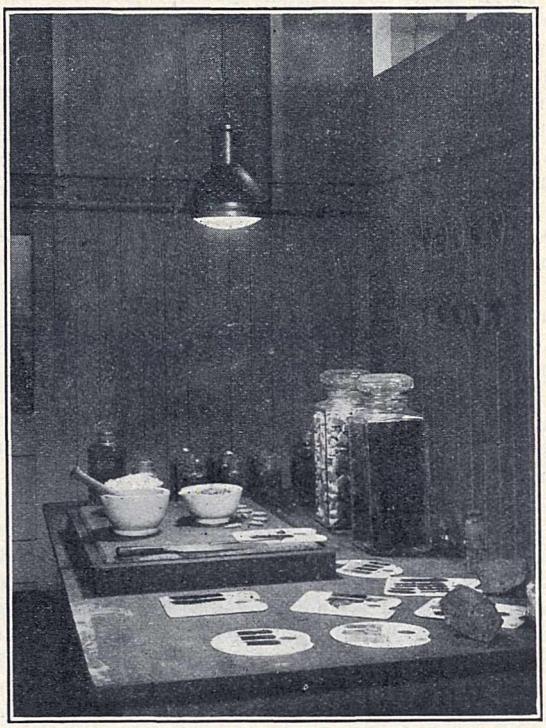

FIG. 2.—Lamplough daylamp (200-watt industrial model) in use at the laboratories of Messrs. Winsor and Newton, Ltd., for grading pigments. By courtesy of The Lamplough Daylamp, Ltd.

A third type of lamp usually employs a simple coloured bulb, either of coloured glass or coated with a gelatin filter. The correction in many of these units is not nearly so thorough, and therefore the luminous efficiency can be kept much higher, perhaps up to 60 per cent. or so. While lamps of this kind give a much better sense of relative value to blues and greens, they are of little use when exact colour matching is of importance, and recourse must therefore be made to the more fully corrected units.

Other types of lamp, of Continental origin, employ two or more colour filters. The light transmitted through these filters is mixed by diffusion.

In considering the spheres of usefulness of such lamps as are at present available, we recall first of all the considerable number of industries in which "grading" and estimations of quality of products by visual appearance are of the greatest importance. Tea, leather, tobacco, seeds, flour, and many other materials are all judged by colour, and until the modern daylight lamps were available a very great deal of time was lost owing to the lack of good daylight often experienced during the winter in industrial towns. So far as can be judged, however, artificial daylight has proved entirely satisfactory for purposes of this kind when sufficient care is employed in choosing a lamp suitable for the work in hand. A jeweller requires a strong light concentrated in a small area, and for this work one of the lamps with a focussing reflector would be best. On the other hand, for warehouse lighting a lamp giving good diffusion, such as the Sheringham Daylight, may prove the more suitable. The fully corrected lamps have been adapted for studio lighting by artists, and for counter illumination in drapers' shops and elsewhere. Fig. 2 shows a "Lamplough" transmission unit in use for grading pigments at Messrs. Winsor and Newton's.

Persons with experience of work with the artificial daylight units learn to adapt their estimations to the relatively constant light of these lamps, and less difficulty is often experienced than in working with highly variable daylight.

The "higher efficiency," and less fully corrected, lamps are applied with success for the lighting of shop windows by drapers and florists. A great improvement in colour values is secured without undue expense. The main factor militating against the employment of artificial daylight for general lighting seems to be a purely psychological one. Objection is taken to the "cold" appearance of the light when contrasted with that from ordinary lamps, but after all the matter is scarcely of importance if the corrected light is readily available when required.

It may be recalled that the difficulty of obtaining a reasonably constant standard of white light is one of the greatest difficulties in the application of colorimetry for modern industrial purposes. Stanford (*Biochemical Journal*, xvii. No. 6, 1923) has recently pointed out the usefulness of an artificial daylight lamp (the Sheringham lamp was actually used) for purposes of colorimetry with limited range colorimeters,[1] and for many chemical estimations, such as comparisons in Nessler cylinders. Artificial light corrected thus, or by a suitable filter of daylight glass, or by one of the laboratory methods described above, is of the greatest service in the more general problem of colour measurement which is being investigated with much energy in Germany and America at the present time, although the subject seems to attract little attention in Great Britain.

In conclusion, one might comment perhaps on the lack of interest shown by commercial firms in the subject of artificial daylight, and the improvement of lighting generally. In 1920 there were 15,000 fully corrected artificial daylight lamps in use in America, and the demand was then rapidly growing. In Great Britain it is doubtful whether a tenth of the American demand has been reached. The saving of time effected by the employment of such lamps in bad weather is so great that this indifference seems extraordinary, and the sooner this state of affairs is remedied the better for those industries to which this subject is of importance.

[1] See "Colour and Methods of Colour Reproduction" (Blackie), p. 114.

The Plant Commonwealth and its Mode of Government.[1]

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

TO describe in any detail the different kinds of receptor, or receiving apparatus, whereby an external stimulus of light, gravity, etc., is registered by the plant, lies beyond the purpose of this discourse. It is, however, essential to that purpose to point out that the region of reception of the stimulus is often separated by some distance from the region of reaction. Cut or burn the root of a sensitive plant, and presently the leaves begin to move. First, those nearest to the base of the stem bend down hingewise on the leaf cushion (pulvinus) and their leaflets fold together; then in succession those higher up the stem undergo a like series of changes, until all have soon reacted to the shock. Place a root on its side and its growing region an inch or so behind the tip, elongating more on the upper than on the lower side, initiates a curvature which continues until the tip points again vertically downward. But if, as Darwin showed, the tip be cut off before the root is placed in a horizontal position, no curvature occurs until a new root-tip has been regenerated. In the intervening days the root continues to grow horizontally. Cover or cut off the tip of the first leaf of a grass seedling and the actively elongating region fails to respond by curvature to one-sided illumination.

It is therefore evident that there is often a definite separation of receptor and effector region, and one of the most interesting problems in plant physiology is to discover how that gap is bridged. In animals nerves serve to connect the receptor organs—the receivers of specific stimuli—and the effector organs—the structures which respond by movement or other definite changes. But though many have sought for and some have thought to find them, those specialised conductors of excitation which are called nerves appear to be absent altogether from plants. Some have believed that the intercellular protoplasmic fibres serve like nerves to conduct impulses. It may be so, but facts are not very favourable to this interpretation of their function. It would, indeed, seem more probable that the protoplasmic intercellular strands serve to transmit not nervous impulses but materials from cell to cell.

There is, however, no need to carry these speculations further, since recent discoveries have thrown a new light and put a different complexion on the mode of transmission of excitation in plants. If a little mica plate be inserted into a cut made half way across the

[1] Continued from p. 15.

tissue of the first leaf of an oat seedling at a short distance behind the receptive tip, excitation resulting from unilateral illumination is transmitted as in intact plants. But if a second plate of mica be inserted in a second cut made on the opposite side at a slight distance from the first no curvature results; the plant remains unresponsive to unilateral illumination. Similarly, as might be supposed, if the tip be cut off completely and replaced so that it rests on a plate of mica introduced between it and the rest of the leaf, curvature does not occur. But if the tip be cut off and glued on again with gelatin, unilateral illumination induces the same curvature as it does in the intact oat leaf. The receptor apparatus in the tip suffers no damage from the operation, and undergoes the same excitation as in the normal plant. This excitation passes through the gelatin to the intact effector region and brings about in that region redistribution and changes in rate of growth which are made manifest by curvature.

There would, therefore, appear to be no escape from the conclusion that that which passes from receptor to effector regions is a stimulatory substance—a hormone. The message transmitted by the receptive tip to the reacting region is a chemical message. As a letter in the post-bag may pass many doors and cause no stir until it is delivered at the right address, so the hormone which evokes heliotropic response passes through or by many cells without, so far as is known, producing any effect upon them. It is not for their address. Only when it reaches the cells beyond the growing point which have ceased to divide and begun to grow in length and breadth does the message which the hormone bears become significant. Similar beheading and reheading experiments have been made by Mr. G. R. S. Snow in my laboratory. Although it might seem unduly sanguine to expect anything to happen after a root tip has been cut off and stuck on again, the experiment, which has now been repeated many times, demonstrates that the receptive tip, after the operation, responds to the stimulus of gravity stimulation, and that the message which provokes curvature in the growing region is transmitted across a gelatin junction. For if after replacement of the cut off tip the root is laid in a horizontal position, instead of remaining in that position as a tipless root does, it curves until the tip points once again vertically downward.

No less remarkable are the discoveries which have recently been made by the Italian physiologist, Ricca, on the much investigated subject of the movements of the Sensitive plant, *Mimosa pudica*, and allied sensitive species. The movements of this plant have often been described and always excite wonder. In tropical countries, where the Sensitive plant grows close to the ground and covers large tracts, any one who walks over it may see the leaves bending down and folding up as his foot approaches, as though the plants were shrinking from impending danger.

Many explanations have been offered of the significance of these movements; but none seems satisfactory. Extreme sensitiveness to contact is not peculiar to the species of Mimosa. It is manifested also by other genera of plants, by Neptunia, which, like Mimosa, belongs to the Legume family, and by Biophytum, *e.g. Biophytum sensitivum*, a member of the Geranium family. A recital of all the interesting experiments which have been made on *Mimosa pudica* from the time of Claude Bernard to the present day is beyond my powers or your patience. Nor is the recital necessary for my present purpose, for the new classical experiments of Ricca, and the as yet unpublished experiments made recently by Mr. Snow, throw new light on the nature of the message which passes to the leaves when the plant is stimulated as it may be by tapping, shaking, cutting, or burning a part of it. Working with strong-growing woody species in the congenial climate of Italy, Ricca has shown that the excitation set up by stimulating a part of the stem travels in the wood. Even after all the other tissues of the stem are removed the excitation continues to pass upward and to bring about progressively the characteristic movements of the leaves. If a length of stem above the point to be stimulated is killed, as, for example, by subjecting it to high temperature, the message still passes and is delivered to the living leaves above the killed region of the stem.

That the excitation is of a chemical nature is shown by cutting the stem, interposing a short tube containing water between the severed ends, and then stimulating the lower part of the stem. Even under these untoward conditions the message is delivered. The hormone, rising with the water current up the vessels, diffuses through the column of water in the glass tube and, passing into the vessels above the cut, travels along them, and at each level at which a leaf is borne, the hormone passes into the motile pulvinus and excites its tissues, so that the turgid cells of the under side of the pulvinus lose water and resilience and, becoming flaccid, no longer bear up the leaf stalk, which therefore falls like a flag at half-mast. As in old times, a knocker-up went round the town leaving his noisy message at the appointed doors, so the hormone, albeit more discreetly, travels through the watery highways of the plant delivering its chemical message as it goes.

Research, however, whilst unveiling old mysteries discovers new ones, and Mr. Snow, who has just come back from studying the behaviour of Sensitive plants in the West Indies, informs me that whilst he has confirmed Ricca's remarkable results, and has shown that the hormone which travels through the wood may be made to diffuse across a film of collodion without losing its potency, has also discovered that this is not the whole of the story. Transmission of excitation in the Sensitive plant is apparently of two kinds. There is the relatively slow transmission of a specific hormone by way of the wood vessels of the stem; but there is also a high-speed transmission, far more rapid and much less far-reaching. When this high-speed transmission of excitation is employed by the stem, the track which it follows is not that of the wood vessels, nor does it lead to movement of more than two leaves above the point of stimulation.

Mr. Snow has demonstrated the existence of these two modes of transmission by the simple device of making very gradually an oblique cut in the stem. As the knife penetrates into the deeper tissues below the cortex—which tissues are known as the phloem or bast—a drop of fluid exudes from the cut. It used to be supposed that this exudation, which escapes from

certain long tubular cells, is the sign of some hydrostatic disturbance in these cells, and that this disturbance leads to the setting up of a pressure wave which evokes the movement of the leaves. But if the knife be stayed at this point, though the water drop gushes out, nothing else happens. Let it, however, be pressed a little so that it penetrates deeper into the bast and reaches to, or almost to, the cambium, which lies between bast and wood, and suddenly the high-speed transmission takes place; in a flash, the nearest two leaves fall. If the knife be withdrawn no further excitation takes place, but if it be pushed home into the wood, the second more leisurely mode of transmission comes into play. The chemical messenger which travels into the water current in the wood vessels is released and, slowly but surely, as the transpiration current rises through the stem, leaf after leaf falls until all have shown by their position that they have received and responded to the message.

These observations come opportunely. Without them I should have been tempted to round off my discourse with a confident generalisation. The varied happenings in the plant commonwealth which I have described—the revival of powers of cell-division in wounded tissues, the heliotropic curvatures of roots and stems, the ordinary response of the Sensitive plant to shock—all are brought about by specific chemical messengers or hormones. Many other phenomena of plant response to stimulation are undoubtedly also due to hormones. May it not therefore be that the mode of government of the plant commonwealth is not duplex, like that of animals, but simplex? Whereas the integration of the animal body into an individual is the outcome of messages of two kinds, the integration of the plant body is effected by messages of one kind only. In the animal body, the two kinds are those messages transmitted at high speed along the nerves and those material messages or hormones, which are distributed by means of the blood stream. In the plant body, messages of the latter kind only are at present and with certainty known to pass to and fro between the members of the commonwealth.

Until, however, the nature of the high-speed transmission of excitation in Mimosa is explored, it would be rash to predict confidently that the fundamental difference between plant and animal will be found to lie in this, that the plant commonwealth has not and never had the means of rapid message-sending which in the animal world takes place by means of the nervous system, and that the passionless perfection of plants has been achieved solely by developing the system of special messengers. Or adopting Bayliss's metaphor: If the integration of the animal is to be regarded as due to the simultaneous employment of a telegraph system and a postal service—one for quick messages which may be of a physical kind, the other for less rapid messages of a material kind—then it may be that the integration of the plant commonwealth has been and is effected solely by the employment of the postal system. One—the animal world—partakes rather of the nature of an empire, and the other—the plant world—partakes of the nature of a commonwealth, and if so the title of my discourse needs no further justification.

Obituary.

PROF. J. G. LONGBOTTOM.

THE death has been announced, at the early age of fifty-four, of Prof. John Gordon Longbottom, of the Royal Technical College, Glasgow, which occurred on June 6 after a serious operation. Prof. Longbottom was a native of Keighley, Yorkshire, and served his apprenticeship in engineering in the works of Messrs. F. and J. Butterfield. His technical education was received at the Bradford Technical College, and a Whitworth Scholarship enabled him to proceed to the Royal College of Science and University College, London, where he became an assistant to Prof. Karl Pearson. About twenty-eight years ago he joined the staff of the Ro ya Technical College, Glasgow, and became professor of mechanics on the retirement of the late Prof. Rowden.

Prof. Longbottom was very retiring, and consequently his abilities were not widely known outside the College. His mathematical knowledge and his power of applying it to practical problems were of great advantage to his students, who will remember him not only for the soundness of his work, but also for the kindliness of his disposition. His appointment was made prior to the erection of the new buildings of the College, and he was therefore responsible for the equipment of the Materials Laboratory—an installation which is worthy of the College. He was a member of the Institution of Mechanical Engineers and of the Institution of Engineers and Shipbuilders in Scotland; he contributed to the latter Institution a paper on the stresses on the rim and arms of a flywheel.

PROF. IAN DEYL.

PROF. IAN DEYL, who died on February 4 in Prague, was born in 1855 in Vysoké Veselí nad lidlinon, and prepared himself for the duties of an all-round practical surgeon. But at last he became an ophthalmologist. I cannot dwell here on his numerous original investigations so far as they refer to medicine, of which the most interesting ones treat of the relations of eye diseases to the diseases of the body. He solved in fishes and birds the most complicated problem of the embryology of the mechanism of the eye, namely, the way in which the crossing of the eye-nerves on the lower part of the skull takes place.

Deyl was a member of the Bohemian Academy of Sciences, of the Royal Society of Bohemia, of the Ophthalmological Society, etc. He was of noble character and a great benefactor of the blind, and an institution for the blind bears his name.

BOHUSLAV BRAUNER.

We regret to announce the following deaths:

Dr. C. E. Moyse, emeritus vice-principal of McGill University, Montreal, aged seventy-two.

Sir Jethro Teall, F.R.S., lately Director of the Geological Survey of Great Britain and of the Museum of Practical Geology, London, on July 2, aged seventy-five.

Sir Harry Veitch, formerly vice-president of the Royal Horticultural Society, on July 6, aged eighty-four.

Current Topics and Events.

A CONFERENCE arranged at the British Empire Exhibition by the Royal Society for the Protection of Birds took place on June 26. The subjects for discussion were legislation for bird protection in different parts of the British Empire, the oil menace, and the formation of Nature reserves and bird sanctuaries. Overseas representatives described the conditions in their respective countries. In some of these the question of the preservation of bird life is a very urgent problem: on the one hand the changes within recent years—owing to the rapid increase of human population and all that it implies—are very obvious, while on the other hand the need for counteracting insect pests is particularly great. In some parts of the Empire, legislation on the subject is ahead of that in Great Britain, but although high penalties are imposed, enforcement of the law is often difficult. One is glad to see this subject discussed in its wider aspects, even although foreign countries were on this particular occasion not included. Owing to the seasonal movements of birds from one country to another, international co-operation in protective measures is highly desirable, and we were told at this conference how much the Migratory Birds Treaty with the United States has done for the Canadian summer avifauna. The oil menace also requires international handling, because the waste oil which nowadays causes so much cruel and unnecessary destruction of birds, as well as of fishes and other marine animals and of seaside amenities, is as a rule originally discharged at sea outside territorial limits.

AT the close of the current session, Prof. J. B. Cohen will retire from the chair of organic chemistry in the University of Leeds, severing a connexion which dates back to 1891. In that year, after some experience in the works of the Clayton Aniline Company and in the Chemistry Department at the Owens College, Manchester, he was appointed lecturer in organic chemistry and afterwards became the first occupant of the chair of organic chemistry established in 1904. To the advancement of organic chemistry Prof. Cohen has contributed very substantially in many ways. His original work has centred, for the most part, in problems connected with substitution in aromatic compounds, with the relation between optical activity and position isomerism and with the influence of chemical constitution on the antiseptic properties of organic compounds. His success as a University teacher has been in no small measure due to his faculty for lucid exposition, to his constant attention to the routine laboratory work of his students, and to his never-failing interest in the difficulties of the beginner. To large numbers of organic chemists, his name is particularly familiar as the author of widely read text-books which have played no small part in attracting students to the study of the subject. As a member of Government Committees dealing with the question of smoke abatement, Prof. Cohen has been able to supply valuable data from first-hand observations on the deleterious effects of smoke. Much of his leisure has been given up to social work, and as president of the University Working Men's Club at Leeds, he has, with much success, laboured to bring University students into contact with young working men, to their mutual advantage. In recognition of his services the funds necessary for the establishment of an annual University prize are in course of being provided by Prof. Cohen's colleagues, friends, and past students. To his colleagues, the approaching retirement is an event rendered less regrettable by the knowledge that arrangements will probably be made for him to continue his experimental work in one of the University laboratories.

A MOST interesting appreciation of Lord Kelvin, the centenary of whose birth has just been celebrated, appears from the pen of Sir Oliver Lodge in a recent number of the *Observer*. As a physicist who can enter into the spirit of Kelvin's work in a way that few others can, Sir Oliver sums up the scientific career and genius of the great pioneer with a wonderful sense of proportion. Attention is directed not only to the vast mathematical power and knowledge that he possessed and applied with such notable results to the foundations of thermodynamic and electromagnetic theory, but also to his all-compelling enthusiasm and his remarkable originality and independence of thought. "Many a German professor and some English professors," writes Sir Oliver, "were more learned than Lord Kelvin, but none were so original. . . . His métier was not to follow but to lead." This independence of thought sometimes brought him into avenues from which he was obliged to retreat. The writer pays great tribute to the practical results of Kelvin's labours. His navigational and electrical instruments are household words to-day, and many of his theories have had unexpectedly far-reaching results. He was, however, not always a good judge of his own work. Sometimes he lost his way and floundered. He was an inspiring rather than a safe and secure guide. "But," concludes Sir Oliver, "he has written his name large on the history of physical science, and all the world marvels at his genius and is thankful that he lived."

THE work of William Pengelly as a geologist and as the explorer of Kent's Cavern will always be remembered by scientific workers, and some of his papers must ever figure among the classics of geological literature. The celebration last month of the jubilee of the foundation of the Museum of the Torquay Natural History Society is a reminder of the way in which he has left a mark in the town which will keep his memory ever fresh in the minds of all who know Torquay. In 1844, Pengelly, Dr. Battersby, Mr. E. Vivian and some fifteen kindred spirits founded the Society, but it was not until 1874 that the foundation stone of the Museum was laid by the Rev. T. R. R. Stebbing, president for the year, who is still with us. In March 1894, Pengelly died and a good lecture hall was added to the building as a monument to his memory. For many years the building has been a worthy focus for the scientific thought and work of the Torquay district, a region peculiarly rich in opportunities for

research. Mr. Harford J. Lowe, the honorary secretary, speaking at a garden party held at Torre Abbey, said: "The life of the Society must be credited in a very large measure to the incomparable work, during many years, of Mr. Pengelly, who through his excavations in Kent's Cavern provided the mainstay of the Society and gave it world-wide notability." This note was echoed at a garden party given by Pengelly's daughter, Mrs. H. Forbes Julian, on the following day, and again by an account she gave to the Society of her father's work. "A man," she said, "is best judged by the work he has done, the influence he has exercised during his lifetime, and the results he has left behind for the use of posterity."

TAKING the weather records at Greenwich Observatory as a fair representation of Midland and South-east England, a consideration of the meteorological results for the first six months of the current year shows a prevalence of dull and rainy weather. The mean temperature for the six months is 0°·15 F. above the normal for the past 35 years, and whilst January, May, and June were warmer than the normal, the months of February, March, and April were colder than the normal. In May, the shade temperature was above 70° on 8 days, the highest reading being 79°; the temperature in the sun's rays was 130° or above on 14 days, the highest reading being 150°. In June, the shade temperature was above 70° on 16 days, and on 2 days it was slightly above 80°; the solar radiation temperature was 130° or above on 16 days, and the highest reading was 149°. The rainfall was in excess of the normal in all of the six months except February and March, yielding a total excess of 2·41 in.; the latter half of June was generally dry, rain only falling on 3 days after June 13. Bright sunshine was deficient in all the six months except January and March, the deficiency for the whole period averaging about a quarter of an hour per day; in April the bright sunshine was 1·66 hours per day less than the normal. Although the weather has continued somewhat unsettled there has fortunately been no recurrence of late of the abnormal conditions which continued with such persistence during the winter and early spring.

IN the *Times* of July 2, Mr. Richard O. Marsh publishes an amplified account of the previously reported discovery of "white Indians" in the district of Darien in Panama. The expedition of which Mr. Marsh was leader made friends with the Indians of the district by rendering medical aid in an epidemic of small-pox. They were then induced by an offer of the assistance of the white man against the surrounding "negroid" tribes to end their feud with the "white Indians," who, as the story goes, were either killed or driven to the mountains at the time of the Spanish occupation (1512–1517) owing to the hatred of all white people which had been aroused by the cruelties of the Spaniards. Notwithstanding a ban on their marriage and an order that all their children should be killed, the type has survived ever since. As a result of Mr. Marsh's intervention, the "white Indians" have been re-admitted to full tribal rights. Dr. Breder of the American Museum of Natural History says in a telegraphic despatch that the three "white Indians," whom Mr. Marsh hopes to bring back with him to the United States, have golden hair, blue eyes and white skins, though two have "liver spots," while their skulls are unusual, being round and quite unlike the San Blas Indian type.

TO the *Empire Review* for July, Mr. Hugo Hirst contributes a thoughtful paper on the World Power Conference. He points out that power schemes require capital, and this capital can only be obtained by international co-operation. The Conference attacks this problem, and the many papers contributed by authors will be a help in finding a solution. Recent developments in the industrial world will probably determine the course of the economic reconstruction of the world. In the author's opinion, this reconstruction can already be seen to be slowly emerging. Increased international co-operation is wanted in science, in engineering, and in research. Modern industry is based entirely on science, and its continuous development is only possible through research. The great inventions such as those made by Watt and Faraday are essentially simple. To put them into practice, however, requires the expenditure of capital, and only large firms can face this expenditure. To the manufacturer, research is an economic proposition. In Great Britain the question of coal conservation becomes more pressing every year. Our easily worked reserves of coal are diminishing, and so the price of coal is increasing. The cost of fuel is a greater burden on industry than ever it has been before. The many papers read at the Conference showing how other countries are attempting to solve the problem will be of permanent value to every engineer.

AT the World Power Conference at the British Empire Exhibition, papers by Mr. J. W. T. Walsh, Mr. L. Gaster and Mr. C. W. Sully dealing with illumination were read on July 4. As Dr. C. H. Sharp, a delegate from the United States, remarked in opening the discussion, it seems an anomaly that out of the very large number of contributions to this conference only three should deal with lighting. For it is estimated that quite half of the total electrical energy produced is applied in the lighting field. Mr. Walsh's paper was concerned chiefly with the activities of the International Illumination Commission, whilst Mr. Gaster showed how these are linked to other organisations concerned with illumination from the national point of view. Mr. Sully's paper was largely statistical. He showed how the average candlepower of lamps used has progressively increased during recent years, and gave some illustrations of the great opportunities for developments in lighting. There is of course every inducement to companies concerned with the manufacture of lamps or the supply of electricity to encourage the study of illumination. But one is glad to note that this interest is not confined to the purely commercial side. It is essential that the views of experts, especially those concerned with the hygienic aspects of lighting, should be heard and that the subject should be developed on scientific lines.

THE value of the agricultural exhibit (Ministry of Agriculture) in the Government Pavilion at the British Empire Exhibition, Wembley, has been considerably enhanced by the issue of a descriptive guide-book providing a short explanation of most of the exhibits. More than a score of research institutes have co-operated in working out a definite scheme, starting with an exposition of soil problems and conditions, leading through a demonstration of methods of plant and animal improvement to problems of nutrition and pathology, and concluding with the economic aspects under the headings of Horticulture and Farming and Agricultural Economics. The guide-book does not attempt to describe each exhibit individually, but gives a short, general outline pointing out what each case is intended to demonstrate. In some instances, as in connexion with wheat breeding, virus diseases and spraying with insecticides, the principles upon which the research is based are given in some detail, to render the object of the work intelligible to the public. In other cases, as with the life histories of insect pests and the section devoted to farm machinery, attention is specially directed to the results already obtained and their application in practice. A further useful purpose served by the publication is to indicate the interdependence of the various branches of agriculture, and to demonstrate the wide range of interests involved and the widely spread efforts that are being directed towards the improvement of this great national industry.

THE Meteorological Office has an exhibit of its work in the Government Pavilion at the British Empire Exhibition, Wembley, and an account of the exhibits appears in the *Meteorological Magazine* for June. The entrance to the meteorological section is at the back of the Government Pavilion. Numerous instruments necessary for weather records and weather forecasting are on view. A continuous record is given of the direction and speed of the wind over the building obtained from a Dines pressure tube anemograph, and the intensity of the rainfall is recorded by an autographic rain gauge. A balloon meteorograph is exhibited, and there is a large working model of this to show how the results are obtained. The instrument records temperature correctly to 1° C. and pressure correctly to within a few millimetres. The walls are hung with specially prepared diagrams illustrating different branches of the work. The preparation of forecasts is demonstrated by members of the office staff and data are collected by a wireless installation from a great part of the Northern Hemisphere. There can also be seen the meteorological log kept on board H.M.S. *Thrush* when His Majesty as Prince George was in command. The importance of meteorology is evidently being increasingly acknowledged.

IN an article in the issue of *Science* for May 2, Prof. F. Cajori of the University of California disposes of some of the more or less popular legends which have grown up with regard to Sir Isaac Newton and his work. The delay of twenty years in the publication of the law of gravitation was not due to his taking 60 instead of 69 miles as a degree of latitude, but to his uncertainty as to how a sphere attracted a particle outside it. The delay of the Royal Society in publishing the "Principia" was not due to the absence of any reference in it to Hooke's previous statement of the inverse square law, but to Newton's desire to stop publication. He did not believe as Cotes, the editor of the second edition of the "Principia" did, in action at a distance, but postulated a medium requiring time to act. He did not reject the wave theory of light in favour of the corpuscular theory, but made use of the idea of ether vibrations wherever it seemed the more suitable. The authoritative works of Brewster, Horsley, and Rosenberger provide no support for these legends, but this cannot be said of the "Encyclopædia Britannica" article on Newton.

IN our issue of June 28 we recorded the tragic death of two members of the Mount Everest Expedition, Mr. G. L. Mallory and Mr. A. C. Irvine. The information then available was a brief telegram; a dispatch which tells us all that is likely to be known has since appeared in the *Times* of July 5. From Lieut.-Col. E. F. Norton's message it appears that the surviving members of the party were to leave the base camp on June 15 for the Rongshar Valley, there to rest for a short period before starting on the homeward march. All the party were suffering from the effects of the high altitude work, and no further attempt to scale Everest will be made this season. Mr. Odell, who was the last to see the two lost climbers, takes up the story and describes the events leading up to the final attempt. On June 6, Mallory and Irvine left the North Col Camp for Camp V. (25,000 ft.), and the next day they went on to Camp VI. (27,000 ft.), which had been established by Norton and Somervell a few days before. The same day Odell arrived in support at Camp V. On June 8, Mallory and Irvine appear to have started on the last stage of the journey to the summit, and at 12.50, in the course of making a survey of the mountain face between Camps V. and VI., Odell observed two figures moving on the mountain above him, a comparatively short distance from the summit. Odell then returned to the North Col, and with Hazard kept watch for the return of the climbers. As they had not returned on the following day, Odell climbed again to Camp V., proceeding to Camp VI. on the next day, but no trace was found of the missing men. To search further was impossible, and the party had to withdraw. The position in which Mallory and Irvine were last seen was determined by theodolite as 28,227 ft. Odell is of opinion that they achieved success but were overtaken by darkness on the return journey, and with this conjecture it seems we must be content.

IN connexion with an article in our issue of April 12 on foot-and-mouth disease, the statement was made that "no one believes that the disease arises *de novo*." M. C. D. Perrine, of Cordoba, Argentine, writes to ask why this belief is held when it must be supposed that diseases must at one time have originated on the earth. This is no doubt true if one is not limited to time. It is a certainty that diseases like smallpox, leprosy, plague and consumption have existed as long

as we have any historical knowledge, and probably for a much longer time. Syphilis is a disease which was formerly believed to have originated *de novo* or was brought to Spain in 1493. The more modern study of original documents has shown that this is most improbable, and there is an accumulating bulk of evidence that syphilis also is an ancient disease. The more rigorously infective diseases are studied, the more easily can it be proved that they are transmitted in succession through a long series of generations.

AT a time when there are signs of an increasing interest in algæ, algologists in all parts of the world will welcome the appearance of a new periodical devoted entirely to their science. The *Revue Algologique* is edited by Dr. P. Allorge and M. G. Hamel, of the Museum d'Histoire Naturelle, Paris, and these French algologists are to be congratulated on their energy and enthusiasm in launching a new journal. The *Revue* is published quarterly, and is obtainable from M. Gontran Hamel, Laboratoire de Cryptogamie, 63 rue de Buffon, Paris 5e; price in France 25 fr., outside France 35 fr. It will contain reviews of all algological papers, commencing with 1923, and is open for original contributions. The first part now issued is well got up and consists of 96 pages. There are several original articles in French and English.

A REPORT recently issued by the Board of Education deals with the progress of the Science Museum during the years 1921 and 1922. The Museum appears to have been much hindered by lack of accommodation, part of the collections (and particularly that relating to fishery) being stored away; while the task of transferring about half of these to new quarters gave the staff plenty of occupation, new (but inadequate) buildings having been put in hand in 1922 so as to become available in instalments in lieu of space ceded to the Imperial War Museum. In spite of these difficulties, creditable progress was made: a number of new exhibits were incorporated, including a historical collection of electrical apparatus lent by the Institution of Electrical Engineers and one illustrating the history of kinematography lent by Mr. W. Day, the series relating to light road transport and to wireless communication were specially developed, an improved system of indexing was introduced and completed, catalogues were published for the sections dealing with textile machinery, aeronautics and meteorology, and much repairing and preparation of models was carried out in the workshops. A minor piece of work of some importance was that undertaken in connexion with the Eötvös torsion balance in the Museum. To the Science Library more than 5000 volumes and 15,000 parts and pamphlets were added, and a new classification scheme was put into effect. The number of readers averaged less than forty a day. The smallness of this number is doubtless due to the fact that the library is less known to scientific workers than it should be.

THE Report of the International Air Congress held in June 1923 has recently been issued as a portentous volume of nearly 1000 pages, edited for the Committee by Lieut.-Colonel W. Lockwood Marsh (London: Royal Aeronautical Society, 1923. 25s.). It embodies a mass of papers and discussion on every field of aeronautical interest, aerodynamics and meteorology, engines and fuels, strength of construction, commercial aviation, legal questions, and medical problems arising out of aeronautical accidents. It is a wonderful record of achievement in so youthful a science. There were gathered together 551 representatives of 21 different nations, but the ex-enemy countries were conspicuous by their absence. This is the more to be deplored since some of the more recent and fundamental advances have been developed by the latter. An international discussion on aerodynamics without Prandtl is like relativity without Einstein. The report demonstrates the useful purpose served in effecting comparisons between the experimental methods pursued in different countries, and stresses the value of standard comparative tests in all existing wind tunnels. Contributors included members of the staffs of the National Physical Laboratory, Royal Aircraft Establishment and of the corresponding institutes in France, Holland, Italy, and the United States. The volume may be taken in fact as the most recent authoritative statement of the present position of aeronautical science both on the theoretical and on the experimental sides. The report is unfortunately marred by a number of misprints in formulæ.

SIR NAPIER SHAW, professor of meteorology in the Imperial College of Science and Technology and formerly director of the Meteorological Office, has been elected a foreign member of the Royal Swedish Academy of Science in respect of his "masterly researches on the domain of meteorology."

A SUPERINTENDENT of Fishery Investigations is required for the purpose of organising a new department of fishery research in the Straits Settlements and Malay States. Particulars of the duties of the post and forms of application may be obtained from the Private Secretary (Appointments), Colonial Office, S.W.1.

APPLICATIONS are invited for two appointments in the Department of Agriculture, Nairobi, Kenya Colony, namely, an agricultural assistant with experience in agricultural practice and ability to carry out crop experiments and to render itinerant and advisory services, and an agricultural chemist able to take charge of the chemical branch and to initiate and undertake research. Applications, upon a prescribed form, must be received before July 15 by the Private Secretary (Appointments), Colonial Office, S.W.1.

THE second annual corporate meeting of the Institution of Chemical Engineers will be held at the Hotel Cecil on Wednesday, July 16, when the president, Sir Arthur Duckham, will deliver his presidential address. During the afternoon session Sir Frederic Nathan will review the work of the Education Committee on "The Training of a Chemical Engineer." The meeting will conclude with a visit to the British Empire Exhibition, and a tour of the Chemical Hall will be made under the guidance of Mr. W. J. U. Woolcock.

THREE Agricultural Inspectors are required for the Agricultural Department, Iraq. Candidates should be honours graduates of a British university, holding a diploma in agriculture, or possessing similar qualifications. The persons appointed will be responsible for work mainly in connexion with cotton development, and there are opportunities for original research in agricultural economics. One of the selected candidates may be appointed Assistant Director of Agriculture at headquarters. It is therefore desirable that at least one of the candidates appointed should have had experience of editorial work in addition to other qualifications required.

MISS C. F. ELAM has been appointed to the research fellowship in metallurgy, of the value of 500*l*. a year for five years, given by the Worshipful Company of Armourers and Brasiers in the City of London, and awarded through the Royal Society. Miss Elam was a student of Newnham College, Cambridge, and has been engaged in research work on the properties of metallic crystals with Prof. H. C. H. Carpenter at the Royal School of Mines for the past few years. She also investigated the method of distortion of aluminium crystals in tension, in conjunction with Prof. G. I. Taylor, at the Cavendish Laboratory, Cambridge, and the results of this investigation formed the subject of the Bakerian Lecture of the Royal Society for 1923.

THE Council of the Royal Society of Arts has awarded the Society's Silver Medals for papers read before the Society during the past session as follows: (*Ordinary Meetings*) — Sir Frank Baines, "The Preservation of Ancient Monuments and Buildings"; Sir Richard A. S. Paget, Bt., "The History, Development, and Commercial Uses of Fused Silica"; Major-Gen. Sir Fabian Ware, "Building and Decoration of the War Cemeteries"; Mr. Frank Hope-Jones, "The Free Pendulum"; Brig.-Gen. Sir Henry Maybury, "The Victoria Dock District and its Roads"; Mr. T. Thorne Baker, "Photography in Industry, Science and Medicine"; Mrs. Arthur McGrath (Rosita Forbes), "The Position of the Arabs in Art and Literature." (*Indian Section*)—Brig.-Gen. H. A. Young, "The Indian Ordnance Factories and Indian Industries"; Sir Richard M. Dane, "Manufacture of Salt in India." (*Dominions and Colonies Section*)—Prof. C. Gilbert Cullis, "A Sketch of the Geology and Mineral Resources of Cyprus"; Sir Frederick Lugard, "The Mandate System and the British Mandates."

Our Astronomical Column.

ENCKE'S COMET.—This is the best known of all the short-period comets, and has been observed at every return for the last century. L. Matkiewicz has taken charge of the computations regarding it that were carried on for a long period by the late Prof. Backlund. He notes that a marked change in the mean motion took place in 1918, similar to that in 1904. Since observations in 1921 were confined to a fortnight, it is very desirable to observe the comet over a long arc at the present return. Its detection in July is possible, and it should certainly be found before the end of August.

The following elements, which include perturbations by Jupiter only, are from *Astr. Nachr.* 5298:

T 1924 Oct. 31, 429 G.M.T.

ω	184° 43′ 43″	1924·0
Ω	334 37 33	
i	12 30 21	
ϕ	57 48 28	
μ	1074″·092	

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R. A.	N. Decl.		R. A.	N. Decl.
July 16.	2h 46m 37s	24° 30′	July 28.	3h 14m 57s	27° 9′
„ 20.	2 55 46	25 20	Aug. 1.	3 25 16	28 8
„ 24.	3 5 10	26 14	„ 5.	3 36 17	29 8

Values of log r, log Δ on Aug. 1: 0·2294, 0·2268.

The comet is a morning object, rising 5 hours before the sun in mid July.

TOTAL LUNAR ECLIPSES.—An article by W. J. Fisher in Brit. Astron. Assoc. Journal for May gives useful hints on the observation of total lunar eclipses. These phenomena were for long regarded as of little scientific value. Then opportunity was taken to improve our knowledge of the moon's diameter by making numerous observations of occultations at the darkened limb. Afterwards it was recognised that study of the illumination of the eclipsed moon gave useful information on the average transparency of the air in the regions for which the moon was in the horizon. A map of the circumstances of the eclipse of Aug. 14 next (partly visible in England) makes it easy to locate these regions for every phase of the eclipse. They lie to a considerable extent over Europe, Africa, and South America, so that direct meteorological observations will be available for comparison with those given by the eclipse.

It is suggested that spectroscopic observations with a large lens and short focus might be made during totality; also the use of screens of various colours might enable more exact determinations to be made of the colours of various parts of the disc. The study is an easy and attractive one for amateur observers.

REPORT OF THE BERGEDORF OBSERVATORY.—This Observatory is carrying on an active programme of work in various fields under its director, Prof. R. Schorr. A second appendix to his "Eigenbewegungs-Lexikon" has just appeared, containing 1248 new proper motions, mostly of stars from magnitudes 6 to 9 and Right Ascensions from 0h to 2h; the astrographic and other recent catalogues have been used in preparing it.

The meridian work at the Observatory includes the re-observation of stars in Rümker's Catalogue, of which a revision was recently published.

Dr. Baade uses the reflecting telescope for the photography of minor planets and comets; the comet found by him in 1922 was followed until the early months of 1924. The very interesting planet 944, found by him, which travels all the way from the orbit of Mars to that of Saturn, has received the name "Hidalgo," after the Mexican hero; this is in recognition of the warm reception given to the German Eclipse Expedition to Mexico in September 1923. Masculine names are given only to minor planets with exceptional orbits, such as Eros and the Trojans.

Prof. Schorr is further engaged on the great "Geschichte des Fixsternhimmels," which contains a summary of all meridian work on the stars from 1750 to 1900. The first 2 hours have already appeared. This work was begun by Ristenpart at Berlin, but was interrupted by his departure to South America, where he died.

Research Items.

PALÆOLITHIC SKULLS FROM CAVES IN SOMERSET.—Vol. ii. part i. of the Proceedings of the Spelæological Society of the University of Bristol contains an important communication by Sir Arthur Keith, describing the skulls found in Aveline's Hole, Burrington Coombe, Somerset. This cave, as has been shown by excavations carried on by members of the Society, served as a dwelling-place—and as a burial place—for man in the closing phase of the Pleistocene period. Of the three skulls described, one is dolichocephalic and two are brachycephalic. Notwithstanding this difference, Sir Arthur Keith is of the opinion that they belong to the same race, the variation in length-breadth index being negligible in view of the identity of other characters, notably the high-pitched cranial vault. In this respect they compare very closely with the new Solutré crania and the Chancelade skull. Their discovery is peculiarly worthy of note, as no brachycephalic skulls of palæolithic date have hitherto been found in England. Although they differ in outline very decidedly from the late palæolithic skulls found both at Ofnet and Furfoos, yet in absolute length and breadth they show a close correspondence to those from the latter locality, while at least four of the intermediate series from Ofnet are comparable to them. Sir Arthur Keith regards them as of Azilian date, but Mr. J. A. Davis in his third report on the excavations, which appears in this issue of the proceedings, holds rather that the Aveline's Hole culture represents an isolated survival of Aurignacian into the late Magdalenian times, to which the occurrence of a typical harpoon, previously reported, seems to point.

MOURNING CAPS OF MURRAY RIVER NATIVES.—Mr. Edgar R. Waite, Director of the South Australian Museum, directs attention in vol. ii. No. 4 of the Records of that institution to a point connected with the mourning caps of the Murray River Natives which has hitherto escaped notice. The mourning caps worn by the widow, relatives of the deceased, and others, after a death, were built up of moist clay on the foundation of a net placed on the head of a mourner, usually said to be shaved for that purpose. Such mourning caps were, naturally, adapted to the shape of the head of the wearer, and also show traces of the process of building up, which was done gradually at different times. These were placed on the grave after an interval. There are, however, other forms of mourning caps which show no trace of having been built up on a foundation, and have obviously been made in one operation; also the interior is neither deep enough nor of the shape to fit on the head. It is suggested that they were dummies which were placed upon the grave by those relatives and others who had ceased to wear a clay cap as a sign of mourning, as the widow continued to do, but still used them in their dummy form as a ceremonial mark of respect to the deceased.

THE ANTS OF KRAKATAU.—In *Treubia*, vol. v. Nos. 1-3, Feb. 1924, Prof. W. M. Wheeler describes a collection of ants made during 1919–21 on Krakatau and adjacent islands and sent to him by Dr. K. W. Dammerman. During the great volcanic eruption of 1883 the fauna and flora of Krakatau, Verlaten, and Lang Islands were completely destroyed, and even Sebesi, at a distance of 15 km., seems to have suffered a similar fate. The study of the animals and plants that are gradually repeopling the islands has received considerable attention. In so far as ants are concerned, it appears that Dr. Dammerman has nearly doubled the known forms from Krakatau, and has much more than doubled the number of those known from Verlaten. The previous collector (Jacobson in 1908), however, used less refined methods of collecting so that the increase may not be entirely due to more recent arrivals on the islands. Most of the ants in the Krakatau group are common species of a wide range in the Indomalayan or even in the Neotropical region. They are hardy forms which survive anywhere in warm countries. Dr. Dammerman believes that many insects may have reached the islands as eggs, larvæ or pupæ, on drifting wood or plants, but contends that dispersal by air plays a more important part than is usually attributed to it. It is significant in this connexion that only one species of ant with wingless females is recorded by Prof. Wheeler in the collection; this evidently supports Dr. Dammerman's opinion.

ENTOMOSTRACA FROM COLORADO.—G. S. Dodds describes the Entomostraca collected by Dr. H. L. Shantz in 1903 and 1904 on the slopes of Pikes Peak (10,000 to 12,000 ft.) and from ponds on the plains near Colorado Springs (6000 to 7000 ft.) supplemented by other records from the State of Colorado (Proc. U.S. Nat. Mus., lxv.). Situated astride the Continental divide, Colorado is the meeting-place of eastern and western faunas, and includes portions of five life zones. The 31 species of Entomostraca found by Shantz fall into three natural groups: 13 found on the plains but not on the mountains; 9 found only on the mountains; and 9, able to live in both warm and cold water, found in both groups of lakes. A similar tripartite division was observable in those collected in Colorado by the author. A graphic representation of the altitudinal range of these species is given, and the author dwells on the significance of these records, especially when it is remembered that the extremes of the two groups of lakes are separated at the most by not more than 10 miles, and yet support Entomostracan faunas as distinct as if separated by hundreds of miles in a north and south direction. The several species common to the two groups stand in strong contrast to the others, and serve to emphasise the fact that temperature may be an effective barrier for some species, but not for others. The paper concludes with a list of the lakes and the species of Entomostraca found in each, with other details.

FEEDING AND DIGESTION IN NEPHROPS.—C. M. Yonge (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 343-389, 1924) gives an account of the mechanism of feeding and the process of digestion in *Nephrops norvegicus*. He describes the anatomy, histology and mode of action of the various parts of the alimentary tract, and records that the enzymes of the hepatopancreas digest starch, glycogen, sucrose, maltose and lactose; the amylolytic ferment finding its optimum in a neutral medium at a temperature of 57° C. The hepatopancreatic secretion also contains a fat-splitting enzyme and a powerful proteolytic enzyme. As in other crustacea, the hepatopancreas stores fat and glycogen, but apparently not calcium.

THE LARVÆ OF THE PEA CRABS.—The zoea larvæ of the pea crabs (Pinnotheridæ) have been studied by O. W. Hyman (Proc. U.S. Mus., vol. 67, Art. 7, 1924) at Beaufort, North Carolina. Ovigerous females were collected and kept in the laboratory until hatching of the eggs took place. The eggs hatch at nightfall. The only feature that is common to the zoea larvæ of this family and serves to distinguish them from the zoeæ of other families is the minute

size of the antenna. In other families the arrangement and size of the spines of the carapace are usually distinctive features of the zoea, but in pinnotherids there is no uniformity in this respect; spines may be prominent or entirely absent. The author gives a key to the known zoeæ. The complete history of metamorphosis has not been followed in any species, but it seems probable that the pinnotherids have at least three—probably four—zoeal stages followed by a megalopa and by the young crab.

TERTIARY CIRRIPEDIA FROM HAITI.—The specific distinctions in Balanus being based upon the opercular plates, no species can be well established until these are known. In their absence the characters of the walls and basis have to be relied upon, and in forms from a restricted area fairly satisfactory results can thus be obtained. Working on these lines, Dr. H. A. Pilsbry describes three forms from the Miocene of Haiti (Proc. U.S. Nat. Mus., lxv.), of which one is doubtful, one described as a new subspecies, and the third as a new species. At the same time, he admits that in the absence of the opercular plates comparison with European Tertiary species is impossible.

PŒCILOZONITES, RECENT AND FOSSIL.—Those interesting land snails belonging to the genus Pœcilozonites are peculiar to Bermuda, and though the living forms have long been known, it is only within comparatively recent years that the fossil ones have been studied. Some of these fossil forms are now dealt with by Dr. H. A. Pilsbry (Proc. Acad. Nat. Sci. Philad., lxxvi.), who proposes two new subgenera: Gastrelasmus for the species having a long, entering palatal lamella, type *P. circumfirmatus* (Redfield), and Discozonites, type *P. blandi*, n.sp. Several new species and varieties are described and illustrated by text figures. Lieut.-Col. Peil, who has recently written on the same subject, states, however (Proc. Malac. Soc. Lond., xvi. pp. 18, 19), that in the living *P. circumscriptus* the internal lamella is sometimes absent.

IMPORTANCE OF MANGANESE IN PLANTS.—J. S. McHargue (*Journ. Agric. Research*, xxvii. No. 6) claims to have obtained data showing conclusively that manganese is an essential element in plant economy and performs an important function, perhaps catalytic, in the synthesis of chlorophyll. Other experiments are being conducted to discover whether manganese is also a vital factor in animal nutrition. In view of the results obtained, and also of the fact that manganese is found in greater quantity in those plant and animal tissues which are richest in vitamins, the author is led to assume that a relationship exists between this element and the vital factors contained in these tissues.

STATISTICS OF INDIAN WHEAT PRODUCTION.—The importance of the application of statistical methods to agricultural problems is exemplified in an article on "Wheat Forecasts in the Punjab" (H. K. Trevaskis, *Agric. Journ., India*, xix. Part III.). Originally crop statistics were based on the requirements of the land-revenue system, but the abnormal conditions created during and after the War led to the development of statistical methods of estimating whether the stocks of wheat in hand were sufficient to feed the great Indian population. At the present time the Punjab wheat statistics, with their bearing on the possibility of export, are of direct importance to the Liverpool wheat market. Forecasts are prepared, of which the first two deal only with the area covered by wheat and cotton, and the last two are estimates of the quantity of the crop actually to be handled. The various methods of estimation of crop yield are discussed, together with the statistical possibilities of estimating the amount required for home consumption. It is suggested that if a census of the stocks in hand could be made at the end of the financial year, it would be increasingly possible to estimate the accuracy of the figures for crop yield and consumption, thus providing more trustworthy data to be considered in controlling the disposal of the wheat crop.

NIGERIAN COAL MEASURES.—Bulletin No. 6 of the Geological Survey of Nigeria deals with the Nigerian Coalfields. Section 1, Enugu Area, is by A. D. N. Bain, with appendices by R. Bullen Newton and Prof. A. C. Seward (London: Crown Agents for the Colonies, 1924. 10*s*. net.) It shows that there are a considerable number of thin seams, but in most of the localities there is a seam of 5 ft. to 6 ft. in thickness, which is evidently workable. A number of analyses are given, showing that the coal is a non-caking coal fairly high in volatile matter and with only moderate ash contents. It is, however, possible that some of these coals may be found to produce a useful coke under suitable conditions. Apparently the coal is a good flaming coal and, therefore, well suited to reverberatory furnace work, so that it would appear to be quite possible to smelt locally the tinstone produced. The total output in 1922 is given as 110,785 tons, and it is shown that the development of collieries in this portion of West Africa is likely to be of very considerable economic importance.

COMPUTATION OF ESTUARY TIDES.—A paper entitled "Estuary tides: a comparison of methods of computation," by Dr. Bell Dawson, the Superintendent of the Tidal and Current Survey of Canada, is given in No. 41 of the Bulletin of the National Research Council, Washington. The subject under discussion is the accuracy of prediction of the times of high- and low-water at stations where the tides are much affected by the presence of shallow water, as at Quebec. The mechanical harmonic prediction as hitherto used for Quebec, though based on the analysis of 19 years' records, gives average errors in high- and low-water times of 26 and 10 minutes respectively. For Father Point, a station 180 miles nearer the ocean, the predictions are similarly based on 15 years' records, and the corresponding average errors are each 6 minutes. To improve on the predictions for Quebec, Dr. Dawson has applied his principle of variable differences, periodic (though not in general harmonic) in the synodic, anomalistic and declinational months. This is a principle which he has used extensively for many years to deduce tidal predictions at a large number of stations from the harmonic predictions for a small number of standard ports. In his present investigation, he regards Quebec as a secondary port having Father Point for its standard, whereas previously Quebec had been regarded as a standard port. By this means the average errors in the predicted times of high- and low-water at Quebec are reduced to practically the same as those for Father Point.

IONISATION IN SOLUTIONS.—In recent years the view has been expressed by several investigators that strong electrolytes are practically completely ionised even at moderate concentrations, and that variations usually put down to varying ionisation are due to varying activities of the free ions. Attempts have been made by Milner to relate the activity to the electrostatic forces between the ions, and, more recently, by Debye and Hückel. In the May number of the Journal of the American Chemical Society Prof. A. A. Noyes gives an elementary deduction of the formulæ, and a comparison with experiment. The

individual behaviour of different ions, in contradiction to the theory, again emerges, but the general agreement is of a very striking character.

ATMOSPHERIC POLLUTION.—In addition to the completed results published in the annual report of the Advisory Committee on Atmospheric Pollution, arrangements have been made for the circulation, month by month, of abstracts showing the records from deposit gauges, so that earlier information can be obtained. The results for April, according to the *Meteorological Magazine* for June, show that in the centre of Liverpool the deposit amounted to 34 gm. per square metre, while on the outskirts of Southport the deposit was only 2 gm. per square metre. In the City of London it was 13½ gm. per square metre. Abstracts can be obtained from the Atmospheric Pollution Committee, 47 Victoria Street, S.W.1.

A NEW SOURCE OF SHORT ELECTRIC WAVES.—The second pamphlet issued by the State Electrical Research Institute, Moscow, is an account by Mrs. A. A. Glagolewa-Arkadiewa of a new method of producing short electrical waves ranging from 0·125 mm. to 50 mm. in length according to the materials used (see also NATURE, May 3, p. 640). This range includes the wave-lengths 2-4 mm. recently produced by Nichols and Tear (*Physical Review*, vol. 2, 1923), and covers the gap between them and the longest produced by Rubens and Baeyer, 0·2-0·34 mm., a dozen years ago by the method of residual radiation. The new method consists in interposing in the spark-gap of the exciting induction coil a paste of fine aluminium or brass particles mixed with heavy machine oil which is carried on the rim of a wheel like a rubber tyre. The wheel dips into a tank of the paste, and by its revolution the paste in the spark-gap is continually renewed. The waves sent out have sufficient energy to allow their wave-lengths to be measured by the mirror method of Boltzmann.

ESTIMATION OF RADIOACTIVE SUBSTANCE BY γ-RAYS.—Dr. W. Bothe describes, in the *Zeitschrift für Physik* for May, observations made at the Reichsanstalt with an apparatus in which varying thicknesses of lead, in the form of a series of concentric hollow cylinders with a total thickness of 11·0 cm., can be interposed between the preparation, which is placed in the axis of the smallest cylinder, and the ionisation chamber. This is a cylindrical sheet iron vessel, with a central cylindrical hollow space having the same radius as the largest lead cylinder, which fits into it. The inner electrode of the chamber is a cylindrical ring of sheet iron concentric with the lead cylinders, and is connected with a gold leaf electroscope on the top of the chamber. The arrangement is very sensitive, so that good readings can be obtained with the full thickness of lead. The absorption coefficients of the γ-rays from the substances to be investigated, in equilibrium with their disintegration products, are 0·50 cm.$^{-1}$ for radium, 0·62 cm.$^{-1}$ for mesothorium, and 0·46 cm.$^{-1}$ for radiothorium; so that it is possible for a mixture of the last two to behave like pure radium, and it might be concluded that it is impossible to distinguish between these two cases by the absorption method. Curves have, however, been prepared, showing the relation between the radium equivalent for the pure substances, and for different mixtures, and the varying thicknesses of the lead filter; in these the "normal value" of the preparation, obtained through 0·5 cm. of lead, was taken as unity. The curves show that it is possible to estimate the amounts of the constituents in any mixture of two of these substances, since even with a mixture of mesothorium and radiothorium, in which the absorption is "equal" to that of radium, the curve is not identical with that of radium, but cuts it at three points, and is easily distinguished from it. Such a mixture together with radium may give a curve from which it is impossible to deduce the relative amounts of the three constituents; but, apart from this, the composition of any mixture of these substances can be estimated from its curve.

WASTE HEAT BOILERS AND VERTICAL RETORT GAS INSTALLATIONS.—Results of tests carried out by the Gas Investigation Committee of the Institution of Gas Engineers at the works of the Birmingham Gas Department, and embodied in the twelfth Report submitted by the Committee to the annual meeting of the Institution, show that by the introduction of the practice of heat-recovery from waste gases in waste heat boilers the thermal efficiency of gas production in normal working with continuous vertical retorts is increased from 60 per cent. to about 66 per cent.

PULVERISED FUEL.—A paper on "Pulverised Fuel and Efficient Steam Generation" read by Mr. D. Brownlie before the Institution of Electrical Engineers last December has already been noticed in NATURE, January 12, p. 62. The paper in full with the discussions which have followed at various centres appears in the Institution's Journal for May. These are interesting because the subject of the relative merits of mechanical stoking and pulverised fuel firing is to-day very controversial and was extensively debated by many speakers. Furthermore, the paper dealt with a single system using a central pulverising plant, and there were a number of advocates of systems employing "unit pulverisers" to each furnace. Again the possibility that the ejection of coal ash would cause a dust nuisance in the densely populated areas of Great Britain aroused much concern. It was urged in reply that this dust is so fine as to be carried far away from the installation so that its final destination is unknown.

PRODUCTION OF TOWNS' GAS BY THE REGENERATIVE GASIFICATION SYSTEM.—A plant for the production of towns' gas from coal by the regenerative complete gasification system introduced by Messrs. M. W. Travers and Clark, has been in operation at Aylesbury since February 1923, and was described at the annual meeting of the Institution of Gas Engineers. The installation has about three times the output of a carburetted water gas plant which previously occupied the site on which it has been erected. Coal is carbonised in an upper section of the plant by internal heating effected by direct transference of heat from hot gases passed through the coal. The resulting coke is gasified by the alternate action of steam and air in the lower section of the generator. Heat is recovered from the blow gas in a regenerator, from which the heated circulating gas passes to mix with the water-gas passing from the lower to the upper section of the plant during the run. The output of gas from the plant is approximately 184 therms of gas of calorific power about 360 B.Th.U. per cubic foot per ton of dry coal gasified. By carburetting, the calorific power of the gas is raised to 420 B.Th.U. per cubic foot. The overall efficiency of the complete gasification process is 55·3 per cent., which compares favourably with an estimated efficiency of about 46·7 per cent. characterising the more usual practice consisting of a combination of a carbonisation process with the production of water gas. Operating charges, excluding cost of coal but including costs of carburetting and purification, amount to 1·39*d.* per therm delivered into the gasholder.

Relativity at the International Congress of Philosophy, Naples.

SINCE the inception of the International Congresses of Philosophy in 1900, it was arranged that such gatherings should be an opportunity for philosophers and men of science to meet on common ground for discussion. Nowadays, philosophers cannot claim to have a complete system unless they account for the various branches of science in their synthetic explanation of things. They must understand what men of science have found out for themselves and give a value to their discoveries in their theories of knowledge. It is quite appropriate then that they should be helped in their efforts by the searching analysis scientific workers have made of their own labours. There cannot be any antagonism between philosophy and science; one completes the other and each is strengthened by the support of the other.

It was a gratifying spectacle to see metaphysicians, logicians, mathematicians, physicists, and biologists sitting together in the great halls of the University of Naples. These meetings formed an integral part of the International Congress of Philosophy, which was arranged at Naples at the beginning of May, under the presidency of Prof. Aliotta, on the occasion of the seventh centenary of the foundation of that University.

Unavoidably the outstanding question under discussion during these joint meetings was Einstein's theory of relativity. Prof. Einstein was, however, prevented from attending the Congress at the last moment. Nevertheless, some valuable papers were read at the sittings of the section of History and Philosophy of Science. Under the chairmanship of Prof. Marcolongo of Naples and then of Prof. Hadamard of Paris, various aspects of the theory of relativity were developed. Prof. Cartan (Paris), in a paper on "The Theory of Relativity and the Generalisation of the Notion of Space," gave an interpretation of Einstein's tensor by means of the notion of curvature and that of the torsion of a curved space, using also Levi-Civita's definition of parallelism. Prof. Hadamard put forward some interesting considerations on the equations of cylindric waves already studied by Volterra. M. Nordmann, of the National Observatory of Paris, dealt with the controversy between Einstein and Bergson with reference to the relativity of time. He contended that Einstein's memoir, published in 1905, gives no ground for criticism, and that Bergson's remarks are based on certain statements, made by Einstein in his popular work, which are open to controversy.

Mr. Zaremba of Cracow, in a paper, "The Theory of Relativity and Experience," pointed out some logical failures of Einstein's theory, and expressed the opinion that at the present stage it cannot be said that experience is for or against it. Prof. Kopff (Berlin) developed some suggestive relations between astronomy and Einstein's conceptions.

Prof. Enriques (Rome), in a paper entitled "A Criticism of the Notion of Time," maintained that time is not only, as according to Kant, the order of internal sensibility, but also that it contains the idea of a natural standard of measure. The analysis of the postulates referring to such a standard reveals the unity of physical forces and the hypothesis that time is independent of space. The rejection of this hypothesis leads to the theory of relativity. Prof. Giorgi acknowledged that the mathematical and logical structure of Einstein's theory is absolutely perfect and quite compatible with natural phenomena. But he does not think that this theory has had sufficient verifications in proportion to its importance and ambitions. Prof. Severi expounded a new method of arriving at Lorentz's classical formulæ by means of an analysis of the concept of time. Prof. Timpanaro, speaking on "The Value of the Theory of Relativity," proposed a new theory, which he called etheral-ballistic, according to which natural phenomena can be explained with as much exactness as with the theory of relativity.

The great opponent of Einstein's ideas was Prof. La Rosa, of Palermo, who spoke on "Some Astronomical Facts against Einstein's Theory based on Ritz's Hypothesis." He showed how to explain several phenomena of variable stars according to Ritz's hypothesis where the velocity of light is compounded with that of force. Einstein's theory, he said, is only one of the possible relativistic ways of interpreting natural phenomena. There is, besides, what he called the "ballistic method," which has much experimental evidence in its favour. The ballistic hypothesis states that the velocity of light can be compounded with that of its source; and when applied to the theory of the double stars it leads to some very interesting and unexpected results. For example, on the basis of the ballistic hypothesis, all double stars having a distance and a period satisfying certain limitations, must appear to us as variable stars. Following up this line of thought, Prof. La Rosa offers a general explanation of the phenomena of double and variable stars.

Among other papers on the philosophy of science, we must mention those of Prof. Vorovka (Prague) and Sittignani, who discussed from different angles Poincaré's epistemological theories, and Prof. Driesch's communication on "The Philosophy of Organic Life." Prof. Hans Driesch, the most authoritative representative of vitalism, explained, with an abundance of examples, that the phenomena of life cannot be accounted for simply by means of physico-chemical processes. Biology shows us that a multicellular organism can be divided up into many parts without stopping its development. A machine cannot be submitted to the same operation with the same results. There must be, therefore, in every living organism a cohesive agent, which he calls "entelechy," the function of which cannot be analysed at the present stage of science, but obviously it causes the organism to develop whatever be the mishaps it may suffer.

In his paper on "The Specification of the Straight Line," Dr. T. Greenwood developed the logical arguments which lead him to state in a new way the problem of the characterisation of the Euclidian straight line by means of a single axiom which he calls "The Postulate of Null-Curvature." He establishes this postulate by means of a new hypothetico-deductive system of axioms based on the notions of "point" and "distance," and uses it to prove the two ordinary postulates of the straight line. This method, which is very simple in itself, has many advantages in the logical, the pedagogical, and the scientific field.

The numerous papers, more than two hundred, read at the Naples Congress did not permit of any discussion, mainly because the time available was not proportionate to their number. This, however, shows admirably the passionate devotion with which Italian thinkers study science and philosophy; and the more so as, besides the International Congress of Philosophy, an Ophthalmological Congress, a Gynæcological Congress, and a joint meeting of the Association of Scientific Societies of Italy, were sitting concurrently at Naples, whilst there was a Sociological Congress and a Eugenics Congress at Rome, and a Geographical Congress at Genoa. Yet, to all those who were able to go to Naples—unfortunately there were not many visitors from Great Britain—the visit will rank among the most pleasant memories of their academical career.

THOMAS GREENWOOD.

The National Physical Laboratory, Teddington.

ANNUAL INSPECTION.

ON Tuesday, June 24, the General Board of the National Physical Laboratory made the annual visitation to the Laboratory. As is usual on this occasion, a large number of members of scientific and technical societies and institutions, members of Government departments and of industrial organisations were also invited to the Laboratory, the whole of which was open for inspection. The visitors were received by Sir Charles Sherrington, chairman of the General Board, Sir Arthur Schuster, chairman of the Executive Committee, and the Director of the Laboratory.

An extensive programme of exhibits had been arranged to illustrate the general character of the work of the Laboratory in addition to features of particular or novel interest.

In the Aeronautics Department the wind channels were shown in operation on various problems which are engaging the attention of the Department. In the 7 ft. wind channel, the airflow round a monoplane aerofoil was being investigated with the object of examining the fundamental assumptions of the Prandtl theory of vortex motion. Special hot wire anemometers, in which the wires are placed along instead of across the air stream, are used to observe the direction and velocity of the air stream. The existence of eddies behind cylinders in an air stream was made evident audibly, by the amplification in a two-valve amplifier and telephone receiver, of the fluctuating potential differences produced by the cooling effects of the eddies, in a hot platinum wire placed behind the cylinder. In the 14 ft. channel, apparatus was on view designed and constructed in the Department for measuring the head resistance of stream line bodies in a wind channel and in the William Froude National Tank. By using the same apparatus in both air and water, the method eliminates the interference between the apparatus and the body under test, so that comparison of the results is possible, and for the first time accurate deductions of the importance of " eddies " in channel work can be made. Other exhibits included the whirling arm and the electrical method of determining the theoretical stream lines for an inviscid fluid moving past a flat plate, both of which were mentioned in the description of the exhibits at the last visitation.

In the Engineering Department, a special electrical dynamometer designed to produce full torque from 20-1700 revolutions per minute was exhibited. The field magnet frame was mounted on roller bearings, and it is claimed that the power transmitted (up to 100 h.p.) is measured to one-tenth of 1 per cent. Another interesting exhibit was that of apparatus for measuring and recording the relative movement of chassis and axles in vehicles. This work has developed in connexion with a general research on springs for vehicle suspension. The effect of shock absorbers in damping vibrations has also been investigated. Apparatus for determining the effect of keys and keyways on the endurance of shafts and for testing brake lining materials was also on view.

In the Metallurgy Department a high frequency induction furnace was shown in which metals can be melted in vacuo without danger of contamination from circumambient gases. The electrolytic preparation of iron and chromium of 99·98 per cent. purity was also on view. In the Wernher Building, interesting microphotographs showed the behaviour of mild steel and brass under the action of cutting tools. These indicated the great importance of the orientation and shape of the tool in determining the ease with which the metal is cut, the character of the finished surface and the wear on the tool.

In the William Froude National Tank a model 10-knot single-screw cargo steamer was shown under test for propulsive efficiency. The thrust and torque of the propeller and the resistance of the hull in water are measured. The plant for making accurate models of ship hulls of a mixture of paraffin wax and beeswax, and also of screw propellers, was on view, and a model propeller was shown under construction.

In the Metrology Department standard weights, including new weights made of stellite, were shown. Various measuring machines designed and constructed in the Department were also on view. These included the " millionth " comparator and tilting level comparator for the comparison of standard length gauges to an accuracy of a millionth of an inch, an improved travelling microscope and the Blythswood diffraction grating ruling engine. Various methods of the application of interferometry to metrological work were shown together with sources of light producing a series of monochromatic rays covering a wide range in wave-length.

A very large number of exhibits was shown in the Physics Department, including a new form of all-metal mercury vapour pump, capable of extremely rapid exhaustion, and a standard optical pyrometer of the disappearing filament type for use up to 3000° A. The most interesting were in connexion with the sound section, in which a photographic method of studying the acoustical properties of rooms was shown. A vertical section of a model of a building was placed horizontally in a trough of water, and trains of water waves were emitted from a point corresponding to the position of a speaker. By projecting light vertically through the glass bottom of the tank, the shadow picture of the disturbance at the surface of the water could be seen on a screen above. This was photographed at certain definite times, enabling the progress of any wave to be followed in its travel across the model of the room, and in its reflections (echoes) from the walls or architectural details. The results have shown in a very convincing manner how in buildings the structural details can interfere with the propagation of speech in certain parts, and the department has been able to make valuable suggestions to improve the acoustical properties. Experimental sounds are very often produced by electrical methods, and an interesting method of study of the purity of the waveforms of electrical oscillations, which are later transformed into auditory oscillations, has been developed. It involves the use of the Weston cathode ray oscillograph, the spot of which describes a circle on the fluorescent screen if the oscillations are sinusoidal.

The Radiology Section exhibited apparatus for the determination of absorption co-efficients, using a metal X-ray tube of high output, for the rapid determination of the lead equivalent of X-ray protective material, and various apparatus for the determination of the crystalline structure of metals and alloys, several of which have been worked out and are of great interest in connexion with the collateral work of the Metallurgy Department on the same alloys. In the Optics Section a new flicker photometer for comparing lights of different colours and improved spectrophotometric apparatus were shown. A constant temperature room has been added to the equipment of this section since the occasion of the last annual visitation and should result in the eventual determination of important optical constants to a greater accuracy than has been possible hitherto. The room is cooled by air from a refrigerat-

ing plant or warmed by air passing over electric heaters; cooling or warming to any desired temperature is automatic through electrical resistance thermometers and relays, and maintains the temperature at any point constant to 0·01° C.

In the Electricity Department, Alternating Current Division, the arrangements for the accurate measurement and calibration of A.C. instruments and of high voltage insulating materials were shown. An interesting phenomenon in dielectric hysteresis was exhibited in which a rotating electric field caused a cylinder of celluloid to rotate. The greater the energy loss due to imperfection of insulation quality, the greater is the torque and the speed at which the insulation material will rotate, except that owing to friction the speed cannot reach that of the rotating field (50 r.p.m.). In the Direct Current Division the association of a hydraulic pressure with endosmosis was exhibited. An electric circuit of 100 volts was earthed under a glass funnel full of damp earth surrounded by water. In the experiment shown, the passage of a few milliamperes caused the water to ascend from the earth to a height of 12 ft. in a tube connected to the funnel. The phenomenon is of interest and importance in the choice of the most suitable methods of earthing electrical machinery and power cables.

The Photometry Division showed exhibits illustrative of the careful work and research which is contributing to the improvement of artificial illumination of all kinds. The experimental building for determining the best methods of utilising daylight was also shown in operation, and a new instrument for measuring daylight factors shown. In the Electrical Measurements Division apparatus showing the accuracy which has been developed in the measurement of frequency in radio oscillations was exhibited. A radio station for the transmission of standardised frequency has been equipped and was open for inspection. In the Wireless Division, apparatus was shown which enables the direction of both the electric and magnetic forces in electromagnetic waves to be determined separately, so that the direction of the wave front is accurately known. This is of interest in connexion with the Beveridge antenna, the action of which is due to the existence of tilt in arriving electromagnetic waves. Among the standard testing apparatus demonstrated were a panel for measuring all the static characteristics of receiving valves, and a set for examining the amplifying properties of audio frequency intervalve transformers. In the latter arrangement the actual voltage amplification produced by a stage comprising one valve and one transformer is measured by a comparative audibility method at any frequency from 250-4000 cycles per second. Using standard types of amplifying valves this measurement enables a study to be made of the frequency distortion introduced into speech-frequency amplifiers by the iron cored intervalve transformers. Other apparatus was shown by which the input and output of any standard type of amplifying detector can be measured, thus enabling a complete study to be made of the behaviour of an amplifier at either radio or audio-frequencies. H. B.

The Natural Resources of Russia.

THE Transactions of the Committee for the Study of Russia's Natural Resources, attached to the Russian Academy of Science, include works of varying type:

(1) Separate monographs—"Precious Stones of Russia," by A. E. Fersman; "A Household Fungus," by I. A. Makrinoff.

(2) Studies of Russia's natural resources—"Russian Wax," by N. M. Koulagin; "Medicinal and Tanin-producing Plants of the Tavricheskaya Province," by B. N. Lioubimenko; "Tea and its Cultivation in Russia," by the same author; "Kendyr (Apocynum Sibiricum Pall)," by I. A. Rajkova; "Russian Sources of Fuller's-earth," by A. E. Fersman; "Beet," by E. V. Kostezky and E. J. Zalensky; "Iodine Containing Lakes of the South of Russia: Eltonskoe, Bakou Iodine Lakes and the Saki Lakes," by N. N. Efremoff, G. G. Ourazoff, and A. E. Fersman; "Bozon," by V. G. Khlopin; "Absorbing Properties of Russian Clays," by P. E. Zamiatchensky; "The Caspian Pilchard," by B. I. Meisner; "Phosphates of the Ukrain," by V. N. Chervinsky; "Tihvin Bauxite," by A. D. Stopkevitch, V. I. Ikskul, and B. P. Ovsiannikoff; "Honey," by I. A. Kabloukoff; "Mica," by I. I. Ginsbourg.

(3) Periodicals—vol. i. of "Wind as Driving Power," by M. M. Rikacheff, A. V. Voznesensky, and T. N. Klado; vol. iv. of "Useful Ores," including: "Silver, Lead and Zinc," by K. I. Bogdanovich, "Gold," by K. I. Bogdanovich, "Vanadium," by K. I. Bogdanovich and K. A. Nenadkevich; "Sulphuric Pyrite," by J. B. Samoiloff; "Russian Coals," with an introduction by P. I. Stepanoff—a co-operative work of 30 specialists of the different coal regions of Russia; "Naphtha and Ozokerite," by D. B. Goloubjatnikoff; "Phosphates," by J. B. Samoiloff and A. D. Arhangelsky; "Felspar," by A. E. Fersman; "Ores of Aluminium," by K. K. fon Foht; "Selenium," by F. B. Bragalia; vol. vi. of "The Animal Kingdom": "Mammals and Birds," by A. A. Silantieff and E. K. Souvorov; "Fishes," by V. I. Meisner, N. M. Knipovich, V. K. Soldatoff, I. N. Arnold, I. D. Kouznezoff, A. I. Golovkin, and A. J. Nedoshivin; "Cattle," by S. A. Ivanoff; "Poultry," by M. I. Diakoff.

(4) Reports on the Activities of the Committee: Minutes xxvii.-xxxiii., reports on 1918 and also reports from 1915 to 1920; and

(5) News from the different scientific institutions attached to the Committee: Institute for the Study of Platinum and other Rare Metals, Institute of Physico-Chemical Analysis.

All the above-mentioned bulky and valuable material in connexion with the natural resources of Russia has been published since 1918–1920. With exceptional feeling and respect one turns over these pages, written by Russian men of science, with a great love of their country, and in circumstances of the greatest privations. These privations affected not only their personal well-being, but also such things as the possibility of getting necessary scientific literature and reagents, and even the temperature of the laboratories. We can get an idea of the hardships they endure by occasional phrases we sometimes meet in their works. We learn, for example, that the temperature of the laboratory of the Polytechnical Institute in Petrograd was the same as that of the street, because the laboratory could not be heated; that the photographic section of the expedition for exploring the Karabougai Gulf could only make negatives because they had no suitable printing paper and equipment to be able to make use of silver bromide paper, etc. In spite of, or perhaps even because of these awful surroundings, Russian men of science have devoted themselves with praiseworthy neglect of self to their scientific work.

"In the dark and even perhaps seemingly hopeless days of Russian everyday life, I have tried," says

Prof. Fersman in the introduction to his book on "The Precious Stones of Russia," "to fly away into the world of the beautiful stone. I want to carry away my friends and the friends of stones from the heartrending surroundings of their everyday life, into another world, and in a number of talks I have tried to show the riches of Russia in her precious stones."

At the head of this Committee there stands a Council of the most prominent men of science. The president of the Council is a member of the Academy —Prof. V. I. Vernadsky—while another member is N. S. Kournakoff, vice-president. The Committee was founded by the Russian Academy of Science in 1915. As Russia during the War was cut off from the world's market, it had to make use of its own resources, and increased knowledge of these natural resources became necessary.

M. Vernadsky expressed this idea in the following words in 1915: "We are in such a position as regards a whole number of our natural products, that we even do not know if we have them, and if we have got them, then in what quantities—all this is because we have got used to getting them from abroad and have given up looking for them in our own country." Russia, therefore, needed a systematic survey of its natural resources in order to become self-supporting. The problem of developing the natural resources has been put forward by the Committee ever since as a great national goal.

The author of the project of founding a special institute for the geographical study of Russia, A. A. Gavriloff, says in May 1919, "The world's economy must pass through an epoch of highly organised national economies, in which the highest possible organisation of production and useful development of the natural resources of the country reduce to a minimum the competition between the different undertakings within the country. In this way is obtained increased economic strength and means for productive competition with other nations. It is only natural that Russia must needs follow along this path."

The Committee of the Academy of Science has rendered a great service to Russia by collecting and systematising so much material in connexion with the natural resources of Russia. Since 1915 to 1920 it has published 13,469 pages of scientific works. This Committee has likewise rendered a service to world economy; every foreigner who wants to take to Russia his capital or his knowledge for the development of Russia's natural resources will find in these works clear and definite answers to the questions which interest him in connexion with different branches of industry.

Limitations of space forbid a detailed account of the works mentioned above. Special attention may be directed, however, to the brilliant work of Prof. Fersman on the precious stones of Russia, and to works with most detailed and careful information on Russian coal, naphtha, platinum, and gold. Attention may also be directed to the energetic action of the Committee in supporting new industries started in Russia before the War began, such as the production of radium and vanadium from the Tuja-Mujunski mines. Before the War this was undertaken and carried out by the Fergan Society of Rare Metals. With the nationalisation of the mines this young undertaking might otherwise have been killed.

The Committee for the Study of Russia's Natural Resources has formed a special section in connexion with rare metals and radioactive substances. This includes such prominent men of science as Vernadsky and Kournakoff, both of whom are members of the Academy, and Profs. Jakovkin, Joffe, Veber, Sokoloff, Lialin, and Khlopin. What is even more, this section has obtained a Government grant, and has started works in connexion with the production of radium. Information relating to this interesting section of the work of the Committee will be found in the Transactions of the Committee of the Academy of Science for 1918.

The Geological History of South-Eastern Australia, with Special Reference to the Carboniferous and Permian Periods.[1]

By C. A. SUSSMILCH.

ROCKS of definite Archæozoic age occur only over a limited area in the western part of south-eastern Australia; they contain the important silver-lead-zinc ore-deposits of the Broken Hill District. Proterozoic strata are limited also to the same area; these contain glacial tillites which have usually in the past been considered Cambrian, but they are probably of pre-Cambrian age. No undoubted Cambrian strata are known to occur in New South Wales.

Ordovician strata are very extensively developed, both in New South Wales and in Victoria: they consist mainly of claystones with some fine-grained sandstones, and contain an abundant graptolite-fauna. Both Lower and Upper Ordovician strata are found in Victoria, but so far only the latter have been identified in New South Wales. Silurian strata are developed over extensive areas in New South Wales, particularly in the southern and central parts of the State, and extend also through the centre of Victoria; in addition to claystones, there is a considerable development of limestones, individual beds ranging up to 550 feet in thickness. An abundant coralline fauna is preserved in these limestones and there are also many brachiopods and hydrozoa.

[1] Substance of a lecture delivered before the Geological Society of London on May 21.

The sea appears to have retreated from the land at the close of the Silurian Period in south-eastern Australia, but renewed transgressions of limited extent took place early in the Devonian Period. The sedimentation which took place in these areas in Lower and Middle Devonian times was accompanied by very extensive deposition of lavas and tuffs, this being one of the important volcanic epochs of south-eastern Australia. Thick coralline limestones were also deposited during that age. Important crustal movements took place at the close of the Middle Devonian times, followed by an extensive transgression of the sea in New South Wales in the Upper Devonian Period, a transgression which extended from the present south-eastern coast almost to the far western boundaries of the State. In the strata deposited in this epicontinental sea an abundant brachiopod fauna is preserved, together with numerous fish-remains. Important crustal movements took place at the end of the Devonian Period, which brought about a complete withdrawal of the sea; much of south-eastern Australia has not since been beneath the sea.

Early in the Carboniferous Period a geosyncline developed in north-eastern New South Wales, and in this was first deposited a series of marine strata in

the latter part of Lower Carboniferous times. Following a withdrawal of the sea, an extensive series of terrestrial beds was deposited in this area in Middle and Upper Carboniferous times; these terrestrial strata consist mainly of conglomerates, volcanic rocks (lavas and tuffs), and glacial beds, of an aggregate thickness approaching 10,000 feet. The glacial beds are of such a thickness and volume as to imply intense and long-continued glaciation. Associated with these beds is a characteristic Rhacopteris fossil flora.

In Permian (Permo-Carboniferous) time an alternating series of marine and freshwater beds was deposited in the north-eastern part of New South Wales, and these extend far northwards into eastern Queensland. The freshwater beds contain the most productive coal-measures of Australia, and associated with the coal-seams is the characteristic Glossopteris flora. The glacial conditions of the Carboniferous Period continued also far into the Permian Period, but with apparently reduced intensity. The Permian Period closed in north-eastern New South Wales and south-eastern Queensland with pronounced orogenic movements, accompanied by granitic intrusions; but elsewhere in New South Wales and throughout Victoria and Tasmania, no earth-folding took place at that time.

In the Trias-Jura Period the whole of eastern Australia stood above the sea, and extended far east of the present shore-line. Upon this land there developed a number of large lake-basins in which several thousands of feet of freshwater strata were deposited, and in some areas productive coal-measures were formed. In the Cretaceous Period a transgression of the sea began in the north, and extended southwards over central Queensland into northern New South Wales, and well into central Australia. At the beginning of the Tertiary Period a tilting of the Australian continent on an east-and-west axis caused the Cretaceous sea to retreat northwards, and allowed of transgression taking place over considerable areas in the south, incidentally separating Tasmania from the mainland.

The close of the Tertiary Period was marked by a great epeirogenic uplift in eastern Australia, which produced the existing tablelands trending parallel to the eastern coast of Australia. The elevation of these tablelands was accompanied by extensive block-faulting. During the Pleistocene Period, limited high areas in New South Wales and Tasmania supported glaciers and ice-sheets; more recently, a subsidence of the land (or raising of sea-level) drowned the shore-line to an extent of about 200 feet, and still later an upward movement of the strand-line of some 10 to 20 feet has taken place.

The Japanese Earthquake of September 1, 1923.

SHORTLY after the Japanese earthquake of September 1, 1923, Mr. Takeo Kato, on behalf of the Imperial Earthquake Investigation Committee, made reconnaissances through the districts of violent shocks, especially those around Sagami Bay. He has published a preliminary report on this field study in the Journal of the Geological Society of Tokyo (vol. 30, No. 361), including some definite estimates of the loss of life and property. In Tokyo, though not a house escaped some damage, the number of houses that collapsed owing to the shock was comparatively small. The latest official statistics place the number of houses destroyed by fire in Tokyo at 316,087, the number of killed at 67,052, of injured at 32,583, and of missing at 38,980. The shocks were far stronger at Yokohama, and strongest of all in the districts around Sagami Bay. In six towns along and near the borders of the Bay, 84,300 houses were destroyed and 26,370 lives were lost.

From seismographic and other evidence, the epicentre of the great earthquake seems to lie in Sagami Bay, about midway between Oshima and Hiratsuka, near the mouth of the Sagami River, and probably a little nearer the latter place. In the two months following this shock, the number of after-shocks was more than 1350; there were 365 on September 1, and 289, 173, and 143 during the next three days; afterwards the normal decline in frequency was manifested. The epicentres of these after-shocks lay at different places more or less remote from the main one. A few minutes after the great earthquake sea-waves swamped the shores of Sagami Bay, from Shimoda in the Idzu peninsula to Misaki and Uraga in the Miura peninsula, and also along the southern part of the Boso peninsula. They caused much damage only at Ito, Atami, Kamakura, and a few other places, where the height of the waves ranged from 20 to 40 feet. No conspicuous sea-waves were seen in Tokyo Bay. No great fault-scarps or traces have been observed, but in the islet of Hatsu-shima, off Atami, a fissure was traced for about half a mile, with in some places a displacement of 3 feet or more, running in the direction N. 30° W. Another, rather more than a mile in length, was found near Nagasawa in the Miura peninsula. Both fissures may be regarded as minor faults of the main fault along which the great earthquake originated.

A remarkable upheaval of the ground took place, it is said, within a few minutes after this earthquake, over an area of about 2000 square miles, including the islet of Hatsu-shima, the headland of Manazuru, the northern border of Sagami Bay, the Miura and Boso peninsulas. The greatest upheaval (about 8 feet) occurred at Tomizaki, along the southern coast of the Boso peninsula, and it is remarkable that here the ground settled down more than a foot within one month after the upheaval. According to the soundings made by the Navy Hydrographic Office, conspicuous changes in depth, of 50 fathoms and more, have occurred at various places in the deepest portion of Sagami Bay. Soundings are still being carried out in the Bay, while many levelling parties of the Military Department are engaged in ascertaining the changes in elevation throughout the earthquake area.

It is worthy of notice that the epicentre lies in the deepest region of Sagami Bay. This trough, which has a N.N.W. direction from Oshima to Hiratsuka, appears to be the southern continuation of the valley of the Sagami River running in the same direction. Moreover, tectonic lines in this direction are numerous, as indicated by the coast borders, valley courses, etc., and the minor faults at Hatsu-shima and Nagasawa run nearly parallel to this direction. The origin of the earthquake is attributed to a great compressive force, probably from the east, which has been accumulating for a long time. The last great earthquake in the district occurred on November 22, 1703, and seems to have originated in a great fault along the same tectonic line, the epicentre lying apparently a little to the south of that in 1923. A similar upheaval of land is recorded at that time.

C. D.

University and Educational Intelligence.

BIRMINGHAM.—At the annual Degree Congregation held on July 5 the Chancellor (Viscount Cecil of Chelwood) conferred the honorary degree of LL.D. on His Excellency Count de St. Aulaire, The Rt. Hon. Reginald M'Kenna, Sir Charles Sherrington, Sir John Bland Sutton, Sir Arthur Keith, Sir Henry Fowler, Sir Graham Balfour, Prof. Samuel Alexander, Prof. G. H. Hardy, Prof. F. Gowland Hopkins, and Prof. P. F. Frankland.

There were 4 successful candidates for the degree of Ph.D. and 18 for M.Sc. In the Honours Schools the degree of B.Sc. was conferred on 3 in mathematics, 8 in physics, 17 in chemistry, 1 in zoology, 3 in botany, 2 in biochemistry, and 26 in engineering, mining, and metallurgy. For the ordinary degree of B.Sc., 62 candidates were presented, and for the degrees of M.B., Ch.B., 29.

Mr. A. W. Nash has been appointed professor in oil mining. Educated as a civil and mechanical engineer, Mr. Nash has had fifteen years' experience in oil mining in Persia, Burma, Egypt, Russia, Hungary, Rumania, and Poland, and for the last two years he has been lecturer in oil mining in the University.

Mr. H. Beckwith Whitehouse has been appointed professor of midwifery and diseases of women. Mr. Whitehouse was educated at Malvern College and St. Thomas's Hospital Medical School, and among other posts he has held that of Hunterian professor to the Royal College of Surgeons, England.

Dr. James Maclure Smellie has been appointed lecturer in pharmacology and therapeutics; and Mr. Bernard G. Goodwin has been appointed assistant to the chair of surgery.

Miss Mabel Geraldine Carter has been appointed temporary lecturer in biology.

Some anxiety has been shown in the local press as to the openings available for the graduates in science now leaving the University. Prof. G. T. Morgan, in a letter to the *Birmingham Post* of July 5, directs attention to the fact that graduates of the University find employment more readily in other large towns than in Birmingham itself. Prof. Morgan observes that he himself is frequently consulted by local manufacturers in search of advice in chemical problems, and he suggests that many of these inquirers would find it highly advantageous to select a chemical staff of their own from the ranks of trained chemists who are being produced yearly in the University.

CAMBRIDGE.—Dr. J. Chadwick, Gonville and Caius College, has been appointed Assistant Director of Radioactive Research at the Cavendish Laboratory. Mr. H. Thirkill, Clare College, and Dr. C. D. Ellis, Trinity College, have been appointed demonstrators in experimental physics; Mr. F. W. Dootson, Trinity Hall, Mr. H. M'Combie, King's College, Mr. W. G. Palmer, St. John's College, and Mr. A. J. Berry, Downing College, have been appointed demonstrators in chemistry. Mr. J. C. Wallace has been re-elected to a junior fellowship at Emmanuel College. H. E. Baker, Corpus Christi College, has been awarded the Wiltshire Prize. Frank Smart Prizes are awarded to R. G. Tomkins, Trinity College (botany), and to G. P. Wells, Trinity College (zoology).

LEEDS.—Headingley Wesleyan College and its extensive grounds have been acquired by the University, and at the beginning of next session will be opened as a University Hall of Residence for 120 men students.

LONDON.—At a meeting of the board of the Middlesex Hospital on July 2, it was announced that Mr. S. A. Courtauld, for many years a generous supporter of the Middlesex Hospital and its Medical School, has given 20,000*l.* to endow the University professorship of anatomy in the Medical School.

IN connexion with the London (Royal Free Hospital) School of Medicine for Women, a 1916 bursary of the annual value of 50*l.* for five years is offered to a student who has matriculated and who wishes to enter the school in October next to begin a full course of study for a medical degree. Particulars of the bursary are obtainable from the Warden and Secretary, 8 Hunter Street, W.C.1.

MR. D. B. J. WALLACE, county agricultural organiser for Devon, has been appointed principal of the East Anglian Institute of Agriculture at Chelmsford.

FOLLOWING upon the death of Prof. J. G. Longbottom, head of the Department of Mechanics, the Governors of the Royal Technical College, Glasgow, have decided to amalgamate the Departments of Mechanics and Mechanical Engineering under Dr. A. L. Mellanby, who will in future be the professor of mechanics and mechanical engineering. Dr. W. Kerr, lecturer in mechanical engineering, has been appointed associate professor in the Department. Dr. Kerr is known for his work on the "Steam Friction of Turbine Wheels" and on the "Critical Speeds of Revolving Shafts," and in collaboration with Prof. Mellanby has published numerous papers dealing with problems connected with steam turbines.

THE University of Sydney loses this year the services of Mr. H. E. Barff, its Warden and Registrar for forty-two years, who is resigning office on account of ill-health. The abnormal increase in the number of students after the War imposed a severe strain on the administrative staff of the University and on its finances. The report for 1923 shows that the number of students in attendance in that year (2755) and in each of the four preceding years was almost, if not quite, double the number in the last year before the War. Since 1920, however, the number has been decreasing. The Sydney University Union, the oldest society of its kind in Australia, and one that challenges comparison with the Oxford and Cambridge Unions, celebrates this year its jubilee.

THE report of proceedings of the Annual Conference of the Universities of Great Britain and Ireland held in May last has been published by the Universities Bureau, 50 Russell Square, W.C.1 (price 1*s.*). The subjects discussed are: Directions in which universities might profitably develop, at the present time, were funds available; the Ph.D. Degree as an encouragement to higher study and research; universities and research in relation to the development of the natural resources and industries of the Empire; interchange of university teachers and students. We have already, in our issue of May 17, given a summary account of the proceedings. The full report covers 63 pages and includes, in addition to the speeches that were delivered, an important paper embodying the substance of a speech which Sir Frederic L. Nathan intended to make on the dependence of the British Isles and the Empire generally on imports from foreign countries and the steps which should be taken to remedy this. There is also a letter from Sir Robert Robertson, Government Chemist, on the difficulty of finding suitable candidates for posts of chemist and agricultural chemist in the Government laboratories in the Colonies.

Early Science at the Royal Society.

July 6, 1663. Dr. Wilkins undertook to engage Dr. Power to make that magnetical experiment here, which he had made in the country, according to his written account sent to Dr. Croune for the society, viz., of altering the polarity of a heated and cooled iron, by repercussing the two ends, and of destroying all the magnetism thereof, by striking such an iron in the middle.

1664. Capt. Taylor related, that he had known a Frenchman, who had a secret of tempering and hardening iron so that it would not rust; adding that the steel of a gun, which he produced, had been put in salt water, and was not affected with any rust; and that the same gun had not been oiled since it had been made, viz., for three years. The artist employed a certain water, which he concealed the ingredients of, wherein he quenched the iron eight or ten times, in order to reduce it to this condition.

July 8, 1663. Dr. Charleton presented the society with the plan of the stone antiquity at Avebury, near Marlborough, in Wiltshire, suggesting that it was worth the while to dig there under a certain triangular stone, where he conceived would be found a monument of some Danish king. Col. Long and Mr. Aubrey were desired to make farther enquiry into it.

1675. Mr. Hooke shewed an experiment concerning the resistance of air to a ball moved with and without an expanded area; of which he was desired to bring in a particular account in writing.

1685. A letter of Mr. Musgrave dated at Oxford, July 4, 1685, was read, mentioning, that a great part of the university being in arms [On occasion of the Monmouth rebellion] the Philosophical Society there was broken up for some time.

July 10, 1672. The Society intending to make a recess for some time, the members were desired, that as many of them, as could conveniently, would meet on Fridays in the afternoon at Gresham-college, to discourse of philosophical matters, and prosecute experiments; among which were recommended—Such, as might determine the queries lately sent by Mr. Newton, which involve his theory of light.—Such, as might improve Mr. Newton's reflecting telescope; and particularly to see finished a four-foot telescope of that kind, already recommended to Mr. Cock.—Such observations as might confirm those of Signor Malpighi about the existence of certain tracheæ, or spiral fibres in vegetables, that contain air: as also to endeavour to the finding out of peristaltic motion, affirmed.

1679. Divers discourses were occasioned about the several ways of tanning leather.

July 11, 1666. Dr. Croune produced a letter, written by Nicholas Stens, from Rome, mentioning the emulation between Divini and Campani about optic glasses. That Campani had been mistaken in some of his observations, taking the spots adhering to the body of Jupiter for the shadows of his satellites.

1667. Mr. Hooke reported that Dr. Croune had received from Mr. Richard Townley, Mr. Gascoyne's instrument for measuring the diameter of the stars with great exactness; which instrument was afterwards shewed to the society, with the models of some others.—Mr. Hooke mentioned, that he had invented an instrument of this kind, but upon another principle which would perform the same things better, with more certainty and more ease.

July 12, 1682. A proposal was read of Mr. John Collins for the printing a book of algebra [Thomas Baker's "The Geometrical Key"]. This was well approved of after a long debate concerning it.

Societies and Academies.

LONDON.

Royal Society, June 26.—J. W. **Nicholson**: The electrification of two parallel circular discs. The paper deals with the general application of spheroidal harmonics to the problem of two bodies not belonging to the same confocal system. The special case of two circular discs is reduced to a mathematical necessity for the determination of an infinite set of coefficients in a series involving Bessel Functions of half-integral order. This in turn is reduced to an integral equation of a new type, the kernel of which is

$$K(x, y) = \frac{\sin a\,(x+y)}{x+y} + \frac{\sin b\,(x-y)}{x-y}.$$

The equation is solved exactly, and exact expressions are found for the capacity of the double-disc condenser, and for the coefficients of capacity and induction of two discs with any charges.—J. F. **Fulton**: The influence of initial tension upon the magnitude and duration of the mechanical response in skeletal muscle. When the unexcised gastrocnemius, sartorius or semitendinosis muscle of the frog is stimulated through its cut nerve under various degrees of initial passive stretch by 50 break shocks delivered at 70 per second, so long as the circulation in the muscle remains vigorous, the following features are to be observed in the successive responses: The greater the initial tension within physiological limits, (*a*) the greater is the plateau tension of the resulting tetanus; (*b*) the longer the time of ascent to the plateau; (*c*) the greater the duration of the plateau *after* cessation of the stimuli ("after-action"). It seems that the general shape of the tetanus curve is determined by the rate of migration of the H-ions of lactic acid, and that the after-action represents the time spent by the ions in migrating from the place of their origin to the contractile interfaces upon which they act. The enhanced duration of the after-action with increasing tension is believed to result from the effect of the increased internal viscosity of the muscle upon the migration rate of the ions.—J. R. H. **Coutts**, E. M. **Crowther**, B. A. **Keen**, and S. **Odén**: An automatic and continuous recording balance. (The Odén-Keen Balance.) An improved form of automatic and continuous recording balance has been devised by combining electromagnetic control with the addition of small weights. A magnet suspended from one arm is attracted by a solenoid-current which is adjusted to maintain equipoise by the automatic movement of a contact along slide wires. The position of this contact is sufficient to define the effective weight, and is recorded on a rotating drum. On reaching a fixed point the contact is brought back to its original position by the addition of a small phosphor-bronze ball to the balance pan, and the cycle of operations recommences. The records consist of a series of stepped curves and a very open scale is obtained so that the apparatus can be used with no appreciable loss of sensitivity up to the maximum load for an analytical balance. Further, the sensitivity can be very simply adjusted for recording either rapid or slow changes of weight.—R. W. **Lunt**: Chemical studies in gaseous ionisation. Pt. I.: This communication constitutes the introduction to a series. Ionisation in hydrogen is produced by the corona due to alternating electric fields of frequency $1{\cdot}5 \times 10^7$. A new analysis of the Siemens ozoniser is advanced which affords a ready determination of the voltage gradient in the gas, and of the current carried by the ions in the gas. The mean intensity of ionisation is calculated from an equation relating the conduction

current in the gas to the known motions of ions and electrons in hydrogen. Pt. II.: The interaction between hydrogen and carbon dioxide due to the ionisation produced by alternating electric fields of frequency $1{\cdot}5 \times 10^7$ has been examined under a variety of conditions. An equimolecular mixture interacts giving a water gas equilibrium, which is also attained by exposing mixtures of carbon monoxide and water vapour to the discharge. In no case has it been possible to detect the formation of formic acid or formaldehyde. The equation used in Pt. I. for the determination of the mean intensity of ionisation in hydrogen has been extended to the determination of this quantity in the above-mentioned water-gas equilibria.—D. W. **Dye**: A self-contained standard harmonic wavemeter. The wavemeter provides a series of harmonics as a result of exactly timed electrical impulses which operate on a highly selective oscillatory circuit. The impulses are provided by either of two multivibrators. One of these has an impulse frequency of 1000 cycles per second, and is controlled in frequency by a valve-maintained tuning fork. The other multivibrator has normally a fundamental frequency of 20,000 cycles per second, and is controlled by the help of the 20th harmonic of the low-frequency multivibrator. The selector circuit consists of a specially designed variable air condenser and a set of six inductance coils of small damping decrement. The six scales are direct reading in frequency, uniform, and cover the range 10 to 1200 kilocycles. Owing to the master control of the tuning fork over both multivibrators, all the frequencies available are accurate to at least one part in ten thousand, and are not dependent upon the calibration, setting, or constancy of any electrical circuit. Intermediary subsidiary harmonics are readily obtainable from the apparatus; by the aid of these, the gaps between the main harmonics can be reduced to about 2 per cent. in frequency in the worst case.—W. L. **Bragg**: The influence of atomic arrangement on refractive index. It is assumed that the atoms, which are polarised by the electric force associated with the light wave, are spherically symmetrical ions, that the elastic yield of the ion to the polarising force is defined by a coefficient λ, which is a constant for the ion concerned, and that the polarising force may be taken to be that at the atomic centre. The birefringence of calcite and aragonite, using the X-ray determinations of crystal structures, has already been explained quantitatively. That of aluminium oxide is now explained. An attempt is made to attack the reverse problem of using the refractivity data to give information about crystal or molecular structure. A comparison of refractivity in carbonates and nitrates indicates a contraction of the NO_3 group as compared with the CO_3 group, and a value for the distance between nitrogen and oxygen atomic centres is obtained.—A. V. **Hill** and H. S. **Gasser**: The dynamics of muscular contraction. In a muscular contraction carried out with various speeds of shortening, the work done is a function of the speed, decreasing as the latter increases. This was previously attributed to the viscosity of the muscle substance. It might depend, however, upon some kind of nervous adjustment carried out through a proprioceptive reflex. The experiments were repeated on an isolated muscle stimulated directly; the same dependence of work on speed of shortening occurred. This is a characteristic, therefore, of the muscle fibre. If the work decreases with increase of speed, so also must the force of contraction, and one striking result obtained is that a quick release of a muscle through 10 to 15 per cent. of its length causes an instantaneous disappearance of tension, which then redevelops along a curve similar to the initial curve of tension development. The viscosity of a muscle increases some fifteen times while the muscle is being stimulated, and it is possible on a viscous elastic model to repeat the phenomena. The fundamental mechanical response of muscle is probably a sudden instantaneous reversible colloidal change which passes off rapidly, the external mechanical response following the internal change, but lagging behind it owing to viscosity.—G. S. **Currey**: The colouring matter of the blue pansy. The anthocyanin pigment of the blue pansy "Emperor William" consists of violanin, and the blue colour of the petals is due to the fact that the pigment is present in the form of its potassium salt; it occurs to the extent of ca. 6·3 per cent. by weight of the dried petals (=1·14 per cent. of the fresh petals). The yellow sap-pigment consists of the flavonol, rutin (viola-rutin). As crude glucoside, it is present to the extent of ca. 9·68 per cent. by weight of the dried petals (=1·75 per cent. of the fresh petals), the actual amount of pure rutin being 50·4 per cent. by weight of the crude substance, *i.e.* the dried petals contain approximately 4·9 per cent. of pure rutin (=0·88 per cent. of the fresh petals).—R. **Snow**: Conduction of excitation in stem and leaf of *Mimosa pudica*.—R. **Azuma**: Thermodynamic phenomena exhibited in a shortening or lengthening muscle. When an excited muscle is released—whether doing external work or not—during the earlier phase of tension development, the heat production is increased; when released at a later phase the heat production is diminished. When an excited muscle is stretched, the converse result is obtained. This suggests that the effects are reversible and thermodynamic in origin, superimposed upon the ordinary irreversible reactions of muscular activity. These conclusions confirm and extend recent observations by Fenn.—H. **Taylor**: The ionic nature of hæmoglobin. By laking the corpuscles by freezing and thawing and suspending in them a collodion membrane which contains a dilute salt solution and is impermeable to hæmoglobin, a Donnan equilibrium is obtained after about three hours. The membrane potential difference is measured and this gives the factor relating the ionic concentrations of the laked corpuscles and those of the crystalloid solution inside the collodion membrane. From this potential difference and an analysis of the crystalloid dialysate, the concentrations of the hydrogen and chlorine ions in the laked corpuscles have been determined. The potential differences found indicate that the hæmoglobin is behaving as an anion over the range of physiological importance. The normality of the hæmoglobin ions present indicates the maximum amounts of carbon dioxide the blood can further take up as bicarbonate.—J. **Stephenson**: On the blood-glands of earth-worms of the genus Pheretima. The blood-glands of three species of Pheretima consist of numerous small spherical follicles within the hinder part of the pharyngeal mass, and on the dorsal side of the œsophagus. A fully developed follicle consists of a fibrous capsule, a cup-shaped layer of nucleated protoplasm, a loose mass of cells within the cup, and a blood-sinus on the convexity of the cup, between this and the capsule. A blood-vessel leads off from the sinus, and another from the opposite pole of the follicle. The follicle is the seat of manufacture of blood-cells and hæmoglobin. The vascular system in annelids and in the groups derived from annelids, and possibly in other groups also, has a double origin; its peripheral portion has been evolved independently of its more central and contractile portion. The analogies between the development of the vascular system in Oligochætes and Vertebrates are convergences, and imply no genetic relationship between the two phyla.—H. Muir **Evans**: Supplementary note on the poison gland of Trygon.—E. M. **Crowther** and

A. N. **Puri**: The indirect measurement of the aqueous vapour pressure of capillary systems by the freezing-point depression of benzene. The freezing-point of benzene is depressed by an amount which is strictly proportional to the aqueous vapour pressure of an insoluble material with which it is in equilibrium, provided that surface energy is not one of the factors determining the vapour pressure of this material. The method is rapid and accurate when applied to substances such as sulphuric acid-water mixtures and certain salt hydrates. With capillary systems such as soil, the equilibrium is reached more slowly and the apparent vapour pressures show a systematic deviation which is the same for soils of widely different types. By assuming that a fraction of the water in such cases is held in micropores and making allowance for the effects of the changes in surface energy on the introduction of an additional liquid phase, it is possible to account for this deviation.—B. **Cavanagh**: Activity-measurement by the partition method. I. A new way of applying the partition-ratio is suggested as an indirect means of precise activity-measurement. Precise measurements are made of a partition-ratio at extremely low concentrations, and preliminary measurements, in the case of lithium chloride between amyl alcohol and water, are recorded, in which the normality, N/8000 (in the alcoholic phase), has been reached. The method consists essentially in the piecemeal preparation of a large amount of the phase to be analysed, and the concentration (for chemical estimation) of the solute therefrom, by a process of piecemeal extraction. The method depends on the possibility of calculating exactly, and applying by successive approximations, a correction for the amount of the solute evading extraction. Approximate values have been obtained, for the first time, for the activity coefficient of lithium chloride in amyl alcohol, at normalities ranging from 0·2 to 0·0001.—J. E. **Jones**: On the determination of molecular fields. Pt. I. By applying the methods of the kinetic theory to a new molecular model, a new theoretical formula for the coefficient of viscosity of a gas has been obtained. In the case of argon, the difference between theoretical and experimental values is nowhere greater than 0·6 per cent. over the whole range of the observations (−180° to 180° C.). Pt. II. The equation of state of a gas has been calculated for a molecular model consisting of repulsive and attractive fields, each according to an inverse power law. The formula for the *second viriel coefficient* thus obtained contains existing formulæ (for a monatomic gas) as special cases. The force constants of a gas are obtained from a comparison of the theoretical formula with observational material on the equation of state. In the case of argon, more than one molecular model will explain the facts.—C. J. **Smith**: An experimental study of the viscous properties of water-vapour. The viscosity of superheated water-vapour over the range of temperature 100°-260° C. has been determined. The method involves the transpiration of the superheated vapour through a capillary tube, determining the pressure at its ends and the mass of the vapour transpired. The variation of the viscosity with temperature can be represented by Sutherland's formula. The dimensions of the water molecule obtained are in accordance with previous investigations for other gaseous hydrides.—E. M. **Crowther** and J. R. H. **Coutts**: Discontinuity in the dehydration of certain salt hydrates. The changes in weight on rapidly drying certain salt hydrates have been recorded continuously by means of the Odén-Keen automatic recording balance. With thin layers of small crystals of copper sulphate pentahydrate and barium chloride dihydrate, the rate of evaporation shows a very marked minimum value at points corresponding to the composition of definite lower hydrates. An explanation of the observations is advanced on the basis of Langmuir's theory that heterogeneous reactions proceed only at the actual phase boundary. No evidence of discontinuities was found in the rehydration of anhydrous copper sulphate.—W. R. **Dean**: The elastic stability of an annular plate. A plane circular annular plate is under uniform shearing forces applied at its edges, and the problem is treated by the methods of the theory of thin shells. Plates with clamped edges in which the ratio of outer to inner radius exceeds 3·2 are discussed. With the analysis given, a certain type of uniform tensional stress can be allowed for in addition to the uniform shear.—R. C. **Johnson** and W. H. B. **Cameron**: The effect of argon on certain spectra. Investigations have been made of the effect of argon on spectra associated with carbon, oxygen, and sulphur; while in certain respects the action of argon and helium is similar, there are also profound differences. It has not been found possible to reproduce the "comet-tail" bands in high pressure argon, but the "triplet system" of carbon is isolated by both the inert gases. An effect of a similar type due to argon has been observed in connexion with sulphur dioxide. A band spectrum of the latter (obtained otherwise only with difficulty) was brought up strongly in the presence of high pressure argon.—G. R. **Goldsbrough**: On the possible ellipticity of Saturn's ring. Maxwell showed that a single circular ring of particles surrounding the planet Saturn would be in relative equilibrium, provided the mass of each particle was sufficiently small compared with the mass of Saturn. This result is extended to the case of an elliptical ring. By properly placing the particles on the ellipse, by allowing the ellipse to rotate slowly in its plane, and the particles to vibrate about their mean positions, then the elliptical ring is a possible dynamical form. For sufficiently small values of the mass of the particles, and for values of the eccentricity not too great, the elliptical ring will be "ordinarily" stable.—E. C. **Titchmarsh**: The double Fourier series of a discontinuous function. The object is to discuss the behaviour of the double Fourier series which represents a function of two variables, at a point where the function is discontinuous. Such a double series is not necessarily convergent in the general sense; but if it is summed in special ways, *e.g.* by rows or by columns, different sums may be obtained, depending on the values of the function in particular regions surrounding the point considered.

Geological Society, June 4.—Dr. J. W. Evans, president, in the chair.—H. H. **Swinnerton**: On a new catopterid fish from the Keuper of Nottingham. Excavations made at Woodthorpe, near Nottingham, passed through the lowest beds of the Keuper Waterstones, and brought to light numerous well-preserved remains of fossil fishes belonging chiefly to the genus Semionotus, together with specimens of a small fish which proved to be a new species of the genus Dictyopyge. This fish is only 4·5 cm. long, and slightly more than 1 cm. deep. In osteological characters it resembles the Eugnathidæ rather than the Palæoniscidæ. The pectoral girdle, however, has an infraclavicle, a feature which is diagnostic of the Catopteridæ. The detailed study of this new species confirms the usually accepted opinion that the Catopteridæ, although classed with the Chondrostei, approach the Protospondyli.—C. E. **Tilley**: A preliminary survey of metamorphic zones in the Southern Highlands of Scotland. A preliminary metamorphic survey of the Dalradian sediments enclosed within a tract extending from Dunkeld in Perthshire to the western side of Lower Loch Fyne (Argyllshire), and reaching from the Highland Border to the Ben Lui Schists that structurally overlie the Loch Tay Lime-

stone (16 miles across the strike), has been made. The important lines of dislocation, such as the Loch Tay Fault, the Luib Fault, the Tyndrum Fault, etc., displace not only the stratigraphical horizons, but also the metamorphic zones, and in the same direction. Where the boundaries of the zones cross areas of marked topographic relief, information should be provided by the trace of the zone surface. The Braes of Balquhidder, near Loch Earn, are thus favourably situated, and examination shows that the boundary-surface (isograd surface) of the almandine zone is there inclined at low angles to the north-west.

Optical Society, June 12.—Col. L. E. W. **van Albada**: Wide-angle ortho-stereoscopy: its optical, practical, and psychological advantages. In the methods used, the objects appear to the observer in their natural sizes and correct spatial relation to each other. These methods are based on the theories of Wheatstone and Helmholtz. The introduction of exaggerated perspective or other unnatural effects is avoided when the stereoscopic photographs are viewed through lenses which have nearly the same focal lengths as those by means of which the pictures were taken, and provided that the stereoscopic lenses are free from distortion. A new type of wide-angle finder made to the author's design gives a clear image over about 85°, with perfect definition up to the edge of the field. —R. J. **Trump**: Binocular vision and the stereoscopic sense. In the appreciation of distance, neither the convergence of the eyes, the visual focus, nor the variation of these accommodations as the eyes sweep over the field, plays any vital part. The recognition of a familiar type of perspective system is important, even to the extent of over-riding the evidence of binocular parallax, when the two come into conflict. This may be shown by reversing the mounting of stereoscopic photographs, or by preparing stereo diagrams in which the perspective is not in accord with the parallactic displacements. Parallax is uncertain, or even breaks down, when not assisted by perspective. There therefore appears to be no "mechanism" of stereoscopic vision dependent upon binocular parallax, but the perception of distance is a psychological function, involving the interpretation of all the details in the images in the two eyes, in the light of previous association and experience.—T. **Smith**: A general solution of the first order aberrational equations. The general equation by which the properties of the component parts of a compound optical system are determined is put into a new form. Solutions are obtained consisting of terms containing arbitrary constants together with any particular solution. The particular solution itself is the sum of two parts, one of which is independent of the corrections required in the complete instrument, while the other contains only the terms which express these special conditions.

CAMBRIDGE.

Philosophical Society, May 19.—Mr. C. T. Heycock, president, in the chair.—C. D. **Ellis**: The high energy groups of the magnetic radium-*C* β-ray spectrum. The magnetic β-ray spectrum of radium-*C* has been remeasured and the absolute energies of the lines found to an accuracy of 1 in 300. Some of the γ-rays giving these lines have energies so great as two million volts, but yet no evidence is found of any abnormal conversion, all the prominent lines being due to conversion in the *K*, *L*, *M*...electronic levels. This renders it possible to find the wave-lengths of the γ-rays. The results bring out the importance of considering the origin of the γ-rays.—R. H. **Fowler**: The statistical theory of dissociation and ionisation by collision, with applications to the capture and loss of electrons by α-particles. The statistics of general two- and three-body processes of interaction by collision are surveyed. In order to preserve standard equilibrium conditions, a definite relation must be satisfied between the number of two-body collisions which lead to any particular type of dissociation (or ionisation), and the number of three-body collisions which lead to recombination by a process which is the exact replica of the process of dissociation with a reversed time scale. This relation is used to study the laws of capture and loss of electrons by α-particles through the interaction of the field of an atomic core. The complete theory predicts Rutherford's V^5-law for the ratio of double-charged to single-charged α-particles, and gives the correct numerical value of this ratio if we may assume, as is reasonable, that the density of lightly bound electrons inside an atom is of the order 10^{24} per c.c.—D. R. **Hartree**: The spectra of some lithium-like and sodium-like atoms. By means of some theoretical relations between spectra of different atoms ionised to such an extent that their electron structures are the same, the position of lines of the spectra of some lithium-like and sodium-like atoms is estimated. In several cases these calculated lines can be correlated with lines observed by Millikan in the hot spark spectra of the corresponding elements. Lines of the spectra Be II, B III, C IV, and possibly N V and O VI, of lithium-like atoms, and of the spectra P V and S VI of sodium-like atoms, are so identified.—H. W. B. **Skinner**: The relative absorbing powers of the *L*-levels for radiation of varying wave-length. The experiment consisted in photographing the fluorescent *L* spectrum of an element using X-rays of varying wave-length to excite it. A change in the relative intensity of a pair of lines shows that the relative absorbing powers of the L_{I} and L_{III} levels depend on the wave-length of the absorbed radiation. This confirms a result recently obtained in a different way by H. Robinson. Hence the well-known λ^3 law of absorption of X-rays does not apply to an *individual L* level.—H. **Hartridge**: Are the overtones of musical sounds always harmonic? There are at the moment two rival theories: one holds that the voice overtones are harmonic, the other that they are not. Evidence available at the moment appears to be in favour of the latter view, not only for the human voice but also for most musical instruments when performing normally.—H. **Hartridge** and F. J. W. **Roughton**: Further developments in the technique for the measurement of the velocity of very rapid chemical reactions. Two different improvements have been effected: (*a*) to make the apparatus available for the investigation of chemical reaction of greater velocity; (*b*) to employ other methods, beside optical ones, for the determination of the stages arrived at by the reaction at different instants of time from its commencement. With regard to the former, it is now possible to make accurate measurements of mono- and bi-molecular reactions half completed in one-thousandth of a second. With regard to the latter, temperature changes in a moving fluid brought about by a chemical reaction can be ascertained by means of thermo-couples.—E. G. **Dymond**: On the measurement of critical potentials of gases. A method of measuring excitation and ionisation potentials is described in which the current-voltage curves are automatically differentiated. This increases the sharpness of the bends in the curves, and results in increased sensitiveness of measurement.—G. F. C. **Searle**: (1) An optical interference method of measuring Young's modulus for rods. A vertical steel rod is deflected by a load suspended from a horizontal arm attached to its upper end. Two horizontal metal plates are soldered to the steel rod and the lower plate carries a lens, the upper surface of which is

convex. The upper plate carries three adjusting screws against which a horizontal plane glass plate is held by springs. An opening in the upper plate allows the observer to view the Newton's rings formed between the lens and the glass plate when suitable illumination by sodium light is provided. The load and the lens are on opposite sides of the rod, and thus as the load is increased and the rod is bent by the bending moment, the distance between lens and plate is increased and the Newton's rings contract. For each ring that disappears at the centre, the distance between lens and plate increases by $\frac{1}{2}\lambda$, where λ is the wave-length employed. (2) A recording gyroscope. A vertical shaft carries a block to which is attached a horizontal axis. The axle of a cycle wheel is carried by a frame turning about this axis. When the wheel is spun and the proper precessional angular velocity is given to the vertical shaft, the plane of the wheel remains vertical. The upper part of the vertical shaft carries a smoked drum on which the record is made by two styles each operated by an electro-magnet. From the record taken can be found (1) the time of one complete revolution in precession, and (2) the number of revolutions of W about its own axis during that time.—D. H. **Black**: Some electrical properties of liquid sulphur. Films of distilled sulphur were obtained between two cones and the conductivity measured at various temperatures up to 200° C. It was found that the conductivity varied in a similar manner to the viscosity. The conductivity of liquid sulphur seems to be electrolytic in character.—T. M. **Cherry**: (1) The integrals of differential equations. (2) Poincaré's theorem on the non-existence of uniform integrals of dynamical equations.—H. W. **Richmond** and F. **Bath**: Loci having two systems of generating spaces.—R. **Hargreaves**: The quadratic form for radial acceleration, in the theory of relativity.—G. S. **Carter**: On the early development of the echinoderm egg. I—III.—D. **Keilin**: On the appearance of gas in the trachea of insects.—G. S. **Adair**: A comparison of the molecular weights of the proteins.—Miss I. A. **Hoggan**: The parasitism of *Plowrightia ribesia*.—R. C. **Woodward**: The overwintering of apple mildew *Podosphaera leucotricha*, in England.—K. G. **Emeleus**: The number of β-particles from radium-E. Using an electrical counter of the type devised by Geiger, the number of α- and β-particles from a source of radium-D, radium-E, and radium-F in equilibrium has been measured. After correction for reflection of β-particles at the source, their numbers were about equal. The β-rays from radium-D would not be recorded under the conditions of these experiments. On this assumption, the observed β-radiation was due to disintegration of radium-E, and since this was in equilibrium with the radium-F, it follows that about one β-particle is emitted per disintegrating atom of radium-E.

Official Publications Received.

Ministry of Public Works, Egypt: Physical Department. 1: Observations of Duration of Sunshine in Egypt and the Errors of an old Type of Recorder; 2: Anomalous Behaviour of the Silk Suspension of a Kew Magnetometer. By H. Knox-Shaw. 3: Corrections to Survey Department Paper No. 33—The Magnetic Survey of Egypt and the Sudan. (Physical Department Paper No. 15.) Pp. 15. (Cairo: Government Publications Office.) P.T.5.

Manchester Test of the Yadil Treatment of Tuberculosis in One Hundred Cases. Preliminary Report. By Alex. Clements. Pp. 28. (London: Quality Press, Ltd.)

Catalogue of India and Burma Forestry and Timber Exhibits in the India and Burma Pavilions; also in the H.M. Govt. Building, Lloyds Bank, Palace of Engineering, etc., British Empire Exhibition, Wembley, 1924. Pp. 139. (London: W. W. Howard Bros. and Co.)

Philosophical Transactions of the Royal Society of London. Series A, Vol. 24. A.620: The Principal Constituent of the Tides of the North Sea. By J. Proudman and A. T. Doodson. Pp. 185-219. (London: Harrison and Sons, Ltd.)

Leeds University. Nineteenth Report, 1922-23. Pp. 180. (Leeds.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Jaarverslag, 1923. Pp. 28. (Weltevreden: Landsdrukkerij.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums, for the Year ending December 31, 1923. By William Henry Fox. Pp. 60+3 plates. (Brooklyn, N.Y.)

Ninty-ninth Annual Report of the Committee of the Bath Royal Literary and Scientific Institution for the Year 1923. Pp. 12. (Bath.)

The Physical Society of London. Proceedings. Vol. 36, Part 4, June 15. Pp. 241-340. (London: Fleetway Press, Ltd.) 6s. net.

Publications of the Kapteyn Astronomical Laboratory at Groningen. No 32: On a Thermo-electric Method of measuring Photographic Magnitudes. By J. Schilt. Pp. ii+31. No. 35: The Proper Motions of the Hyades derived from Plates taken at the Helsingfors Observatory, by Prof. A. Donner. Measured and discussed by Prof. Dr. J. Van Rhijn and W. J. Klein Wassink. Pp. ii+19. (Groningen: Hoitsema Bros.)

Royal College of Surgeons of England. Annual Report on the Museum, by the Conservator. Pp. 24. (London: Royal College of Surgeons.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 2. Pp. 83-199. (Cambridge: At the University Press.) 5s. net.

Commonwealth of Australia: Institute of Science and Industry. Second Annual Report of the Director for the Period from the 1st July 1922 to the 31st December 1923. Pp. 76. (Melbourne: Albert J. Mullett.)

Department of Agriculture, Ceylon. Bulletin No. 55: Improvement of Yield in Hevea by the selection of Seed Bearers. By G. Bryce and C. H. Gadd. Pp. 42. Bulletin No. 68: Yield and Growth in Hevea Brasiliensis. By G. Bryce and C. H. Gadd. Pp. 74. (Peradeniya). 15 cents each.

Report of the Proceedings of the Fifth Entomological Meeting, held at Pusa on the 5th to 10th February 1923. Edited by T. Bainbridge Fletcher. Pp. xiii+422+38 plates. (Calcutta: Government Printing Office.) 9.8 rupees.

Government of Madras. Annual Report of the Chemical Examiner, 1923. Pp. 13. (Madras.)

University of Illinois Engineering Experiment Station. Bulletin No. 142: An Investigation of the Fatigue of Metals, Series of 1923. A Report of the Investigation conducted by the Engineering Experiment Station, University of Illinois, in Co-operation with the National Research Council, the Engineering Foundation, the General Electric Company, the Allis-Chambers Manufacturing Company, the Copper and Brass Research Association, the Western Electric Company. By Prof. H. F. Moore and Prof. T. M. Jasper. Pp. 88. (Urbana, Ill.: University of Illinois.) 45 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1407: The Mexican Bean Beetle in the East. By Neale F. Howard. Pp. 14. Farmers' Bulletin No. 1408: The House Fly and How to Suppress It. By L. O. Howard. Pp. 18. (Washington: Government Printing Office.) 5 cents each.

Proceedings of the Royal Society of Edinburgh: Session 1923-1924. Vol. 44, Part 2, No. 12: A Static Model for Helium. By Dr. H. Stanley Allen. Pp. 116-128. 1s. Vol. 44, Part 2, No. 13: The Cathode Fall of Potential in a High Voltage Discharge. By G. P. Thomson. Pp. 129-139. 1s. Vol. 44, Part 2, No. 14: The Electrolysis of Mixtures of Acetates and Trichloracetates. By Ralph Edward Gibson. Pp. 140-152. 1s. 3d. (Edinburgh: R Grant and Son; London: Williams and Norgate.)

Bulletin of the National Research Council. Vol. 8, Part 4, No. 46: The Geological Implications of the Doctrine of Isostasy. By Andrew C. Lawson. Pp. 22. (Washington, D.C.: National Academy of Sciences.) 40 cents.

Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 57: Large Mollier Chart (Foot-Pound-Fahrenheit Units) Properties of Ammonia. 48 in. × 20 in. (Washington: Government Printing Office.) 10 cents.

Proceedings of the Society for Psychical Research. Part 93, Vol. 35, June. Pp. 285. (London: Francis Edwards.) 16s. net.

City and County of Kingston upon Hull: The Third Port of the United Kingdom. (British Empire Exhibition, Wembley, 1924: Hull Civic Fortnight, July 2nd to July 15th.) By T. Sheppard. Pp. 40+8 plates. (Hull: Municipal Museums.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik Amtliche Veroffentlichung. Jahrgang 1919. Neue Folge, Band 56: Pp. xvi+A36+B35+C72. (Wien: Gerold und Komp.)

Diary of Societies.

TUESDAY, JULY 15.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London) (at University College), at 9.45 A.M.—Inaugural Meeting.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

WEDNESDAY, JULY 16.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at Hotel Cecil), at 11 A.M.—Sir Arthur Duckham: Presidential Address.—Sir F. Nathan: The Work of the Educational Committee on The Training of a Chemical Engineer.—E. A. Alliott: Self-balancing Centrifugals.—G. W. Himus and Prof. J. W. Hinchley: Evaporation in Currents of Air.

FRIDAY, JULY 18.

ROYAL METEOROLOGICAL SOCIETY (Summer Meeting at the Rothamsted Experimental Station, Harpenden), at 2.15.—R. A. Fisher: Adaptation of Variety to Climate.—W. B. Haines: A Comparison of Three Different Types of Radiation Recorders.—Dr. B. A. Keen: A Study of Ground Water Level Changes in Soil Cylinders.

SATURDAY, JULY 19.

PHYSICAL SOCIETY OF LONDON (Special Meeting at Cambridge), at 4.15.—Sir J. J. Thomson: Radiations in a Discharge Tube.—Sir Ernest Rutherford and Dr. J. Chadwick: Recent Experiments on the Artificial Disintegration of the Elements.—Dr. G. F. C. Searle: A Two-dimensional Recording Accelerometer for Aeroplane Research.