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CONTENTS.

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National Eugenics.

THE first parts of the new journal of the Francis Galton Laboratory for National Eugenics[1] should remove many misconceptions concerning both the methods and utility of later developments of the science which Galton founded. The editors contribute a short foreword reviewing the reasons which have prompted them in launching another large vessel of scientific journalism. Their tone may be considered in some quarters unduly combative; but it would be difficult to point to any accusation of prejudice or ignorance, explicit or implied, not strictly justifiable. When they state that "our journal will differ from existing journals in that . . . the papers published will be the work of trained scientists rather than of propagandists and dilettanti," the scarcity of journals devoted wholly to the scientific treatment of racial problems must be borne in mind. There appears to be no need to scent a slander upon all methods but those mathematical. Heredity may be viewed from other not less 'scientific' points of view than those of statistics.

Naturally, "a journal issued by the Galton Laboratory will be sympathetic to the methods of its founder, summed up in the title of his Herbert Spencer Lecture, 'Probability the Foundation of Eugenics.'" But the harvest of other disciplines is not excluded. Every new science is an "unclean novelty," and as a field for prejudices "the study of agencies under social control that may improve or impair the racial qualities of future generations, physically or mentally"—the subject of the Galton Laboratory—has been and is singularly fruitful. If impatience with prejudice is intelligible, so is impatience with the vague and dubious expressions of much descriptive biology. Yet no one knows better than the workers of the Galton Laboratory the importance of qualitative characters and the difficulties imposed by the absence of definitions where exact measurement is impossible.

Ultimately it is to descriptive biology that the biological statistician must go for scientific data. In practice the biometrician, if he has at times found fault with what he has received, has never disdained to seek light, in sociology or in medicine, upon his problems. The biologist, secure in a formulated if not a stereotyped discipline, has found no need for statistical aid, and thus has received less pressure to inform himself of even the most elementary details of his colleague's procedure. "Obsolete lumber" or not, the biological statistician is a fairly energetic raider of the storehouses of qualitative description. What is the truth underlying the editors' assertion that "eugenics requires

[1] "Annals of Eugenics," vol. i. parts 1 and 2. Edited by Karl Pearson, assisted by Ethel M. Elderton, 1925. (The University Press, Cambridge.) Annual subscription, 50s. net.

now, and will require still more as it advances in the future, the most highly trained scientific minds," if it is not a plain admission that their science is a discipline as well as a technique, and that the only facts they can afford to condemn or opinions to despise are those that are false ?

The present issue contains a pedigree of Epicanthus and Ptosis by C. H. Usher, a note on the correlation between birth- and death-rates, with reference to Malthus's interpretation of their movements, by Anthony B. Hill, and the first parts of two larger studies—one on the "Problem of Alien Immigration into Great Britain," by Karl Pearson and Margaret Moul, and the other on the "Relative Value of the Factors which Influence Infant Welfare," by Ethel M. Elderton, based on data provided by the Medical Officers of Health for Rochdale, Bradford, Blackburn, Preston, and Salford. Than this last it would be difficult to imagine a better illustration of the scope, methods, and difficulties of the technique adopted. The subject is essentially statistical but is complicated by all manner of circumstances from which an inquiry like that of the senior editor and his collaborator is free. For example, among the factors influencing viability, are considered the health of the parents, the habits of the parents, the condition of the home, the occupation of the father, the place in family of the child, the age of the mother at birth of the child, and the employment of the mother.

Surely it is of importance that questions of such social value should be studied and judged by methods more refined than those of casual acquaintance. It is impossible to read Miss Elderton's judicial reviews of her own results—which need not be summarised here as they are incomplete—without attaching to them a higher value than the partial results of other methods can claim. The same applies to the paper on alien immigration, the authors of which conclude that restriction is both nationally eugenic and practicable. With regard to both, some sentences in the latter paper may be quoted :

"For the practical purposes of prognosis there does not exist in the present material any correlation of the slightest consequence between the intelligence of the child and its physique, its health, its parents' care or the economic and sanitary conditions of its home. No doubt the indiscriminative critic will assert that we advocate poor physique, carelessness in the parent, uncleanliness in the child with overcrowding and poverty in the home. The workers in the Galton Laboratory are fairly inured to that type of criticism. They hold, however, that the decencies of life are worth fighting for and obtaining for their own sake, and without an adventitious stimulus from vague assertions that their absence is the chief source of stupidity, if not indeed of mental defect, in the child. Philanthropists, seeking to reform deleterious conditions, never gain in the long run, when they proclaim, without due research, that these conditions are the unquestionable cause of all concomitant evils."

There was never such pressing need as to-day for the work of such a laboratory as the Galton Laboratory ; only by the skilled and methodical sifting of facts can be reached a state of knowledge that will lead to a raising of the standard of national fitness.

The Study of History.

Geschichte der Mathematik und Naturwissenschaften im Altertum. Von Prof. J. L. Heiberg. (*Handbuch der Altertumswissenschaft.* Fünfter Band, Erste Abteilung, Zweite Hälfte.) Pp. v+121. (München : C. H. Beck'sche Verlagsbuchhandlung, 1925.) 7·50 gold marks.

THE fact is so well known that it is neither flattery nor even compliment to say that Prof. Heiberg is one of the most learned of living men. Theodore Gaza, I feel sure, knew no more Greek than he, nor can Casaubon or Selden or Bentley have been more industrious and more erudite. The booklet now before us is one of the least of Heiberg's works, but it is an astonishing performance ; for he has managed to fit a real history of ancient science into its 120 pages. A reasonable share, some fifty pages, goes to the great subject of mathematics ; a delightful sketch of ancient medicine occupies the last thirty pages of the book ; and between the two are readable and most instructive chapters on astronomy, mechanics, optics, music, and natural science.

When Zeuthen, another very learned Dane, wrote his short "History of Mathematics," he was more concerned with the development of mathematical concepts than with the precise part in that historical evolution which A or B happened to play ; his little book was not over-full, but it was the perfection of lucidity. Prof. Heiberg's book is of a different kind, for it is an encyclopædic article which he has undertaken to write. It is packed to overflowing with information, but it is still exquisitely clear ; it seems to touch on everything, and to omit nothing. Short as it is, every student of the history of science will want to keep it by his side.

To epitomise the long chapter on mathematics is beyond our powers ; let us glance at the shorter chapter on ancient astronomy. Anaximander comes first, disturbing the old Homeric cosmogony ; the Pythagoreans, Philolaus, Anaximenes, and the rest, down to Oinopides and Anaxagoras, are next passed in review. Plato is shown to have given a firm foothold to astronomy in Athens, and we are told how the fantastic or at least poetic cosmology of the "Timaeus" and the

"Phaedo" led on to the more prosaic but more scientific work of Eudoxus and Callippus. There follows the great figure of Aristarchus (for whom we are, of course, referred to Sir Thomas Heath), and with Aristarchus we seem to have well-nigh reached to the Copernican system; Heiberg does not forget to tell us, from Plutarch, how Cleanthes abandoned Aristarchus's views as impious, and how Seleucus alone clave to him —that Seleucus who, together with Heracleides, would seem to have been the first to conceive of our universe as ἄπειρος, or infinite.

The rival theories of epicycles and of circular but eccentric orbits are next discussed, and the particular relation of the former to the cases of Mercury and Venus is shown to foreshadow the views of Tycho Brahe. Meton and Euctemon, the great Athenian calendar-makers, come next in order; and then we pass quickly to the story of the constellations, and to the popular poem of Aratus, with its many translators and commentators—that very poem which St. Paul quoted in his sermon on Mars' Hill. Hipparchus, Theon, and Ptolemy are all discussed quietly and even leisurely. Next come Proclus and the other Neo-Platonists; then the few Roman scholars, such as Varro, Seneca, Martianus Capella, Manutius and Manilius, the last of whom plays his part, with Manetho, Firmicus, and Hephaestion, in the long history of astrology. Even the Byzantines, such as that great scholar of the eleventh century, Michael Psellus, or Leon the Philosopher, or Manuel Comnenus the Emperor, are not forgotten; and who knows the Byzantines better than Prof. Heiberg? The footnotes and references to books and scattered pamphlets are very copious; and out of his vast knowledge of MSS. Heiberg points out every here and there how this or that remains to be studied: how a commentary of Michael Psellus on Ptolemy lies uncollated in Paris, how a MS. of Theodore Metochiton awaits an editor in the Marcian, or how there is still much more of Vettius Valens than Cumont or Boll have told us of.

Prof. Heiberg handles the immense literature of ancient mathematics, medicine, and the natural sciences with the selfsame ease. His story runs so smoothly it never reads like a compilation: we feel all the while that the writer is giving us only what he has made his own, that he has endless material in reserve, and that he can afford us little allusions and sidelights in plenty, which are far beyond the mere compiler's reach and ken. It is not everybody who happens to know that Jo. Philoponus and Simplicius, the Aristotelian commentators, were at daggers drawn; or that Barlaam of Calabria (who paraphrased the 2nd Book of Euclid) was the schoolmaster both of Petrarch and of Boccaccio.

D. W. T.

Photosynthesis.

Photosynthesis: the Assimilation of Carbon by Green Plants. By Prof. Walter Stiles. Pp. vii+268. (London: Longmans, Green and Co., 1925.) 16*s. net.*

A WRITER of some considerable eminence says, in prefacing his account of one of our English shires, "In the account which follows my aim has been to gather a . . . bouquet rather than to present the facts which the more practical traveller requires." Prof. Stiles is less definite in his preface to the highways and byways of photosynthesis. In his preface we find "an attempt is made to present a view of our present knowledge . . . it is intended to be more general in its scope" than an earlier account by Prof. Stiles and Mr. Jörgensen, which "was essentially a critical account of what were then recent developments of the subject." Further on we find that the present account "is not simply a critical review of recent developments." We are left in doubt as to whether our fate is facts, bouquet, or both.

We find that our guide has not stinted us of facts on the structure of assimilatory organs, the composition of the protoplasm of non-assimilatory organisms, the chemical composition of the green and yellow pigments of the leaf and how to separate them, the methods of measuring assimilation, the variation of the rate of the process with change of external and internal factors, and so on. In fact, we might almost say that the author's hope "that no important work has been overlooked" has been realised.

Bouquets are, however, subtler and personal things in more ways than one. Selection and perhaps arrangement are required. If we have all the facts it is perhaps hopeless to expect selection, but one does look for some indication of the reaction of the collector to the facts he brings together for us. Prof. Stiles usually refrains from revealing himself, and when he does make comments he is sometimes misleading. In his account of methods of measuring photosynthesis he commits himself to saying that the continuous current method is the most reliable of all methods that have been evolved for measuring photosynthesis. Apart from the facts that 'continuous current' describes the supply and removal of substances rather than their measurement, and that the reliability of the measurement is not affected by the method of supply, the subject has many aspects. What is the explanation of the low values obtained by Brown and Escombe when using this method? That these values are low is shown by the rate at which the plant increases in dry weight under natural conditions. Prof. Stiles puts forward as an objection to the eudiometric method the fact that the transpiration of a leaf into a closed

space disturbs the water relations of the leaf. We imagine that disturbed water relations is the explanation of the discrepancy between the results of Brown and Escombe and those obtained by other methods. The real point is that with different technique we have different sets of conditions both external to and inside the assimilating organ, and it is not reliability of method but the type of problem tackled which usually decides the technique. The quotation of the expression

$$x_{O_2}=\left[v_G \cdot \frac{273}{T}+v_F a_{O_2}\right]\frac{P-p}{76{,}000}\left(\frac{b_{N_2}}{b'_{N_2}} \cdot b'_{O_2}-b_{O_2}\right),$$

used by Warburg in calculating assimilation, makes one wonder for what class of reader the book is intended.

The author is not much happier in expressing himself when he is commenting upon the experimental results recorded. In the section on the relation between rate of assimilation and the concentration of carbon dioxide, we find "Warburg selected the unicellular alga *Chlorella* because in such a minute object the concentration of carbon dioxide at the surface of the chloroplast must be in approximate equilibrium with that in the water outside so that complications introduced by the diffusion stage are practically eliminated." What the complications are is not stated, but presuming that equilibrium means equality, we think that the author might have explained how size of object came in, and referred to the importance of the medium, water or air, and the relative amounts of carbon dioxide and bicarbonate. Later we find that in the experiments of Blackman and Smith it "does not appear likely that the rate of photosynthesis might have been determined by the diffusion." Whatever the author may mean, this statement is misleading, for no matter what the nature of the organism the rate of photosynthesis *is* the rate of supply of carbon dioxide to the seat of the reaction.

It is remarks such as the above that make one feel that our author, to return to our earlier analogy, is but a hurried visitor to our shire, and that but few of our intricate scenes have bewitched him so much that he has lingered awhile, and perhaps none has returned to him in his sleep. With so much ground to cover, it would perhaps be unreasonable to expect much of a visitor

We have discovered but one error. The experiments of Willstätter and Stoll with elm leaves were carried out with a light intensity which these workers call 24,000 lux, and not 48,000, as stated on p. 181. We should also like to protest against the continued confusion of Blackman's Law of Limiting Factors and the laws of Liebig and Malthus. The first refers to rates of a process, whilst the last two refer to size of a community of organisms.

It would indeed be surprising if the first book of its type were perfectly satisfactory. Plant physiologists and others are indebted, however, to Prof. Stiles for courageously pushing on where others have hesitated. The presence of more than eight hundred and seventy references in the bibliography may give some idea of the labour involved. G. E. B.

The Integration of Physiology.

Principles of Human Physiology. By Prof. Ernest H. Starling. The Chapter on the Sense Organs edited by Dr. H. Hartridge. Fourth edition. Pp. xiii + 1074. (London: J. and A. Churchill, 1926.) 25*s*. net.

IT is not too much to say that the "Principles of Human Physiology" forms a definite landmark in English text-books on this subject. It is not many decades since a comprehensive text-book on physiology could have been written by almost any professor of the subject. To-day, owing to the rapid growth and differentiation of the subject, for which the large amount of research work and the still larger volume of published matter are responsible, there are few of our experts who would care to attempt the task, and of these a still smaller number would have any chance of success, so difficult is it to keep in touch with the advance of a subject which avails itself of the contemporary advances in so many other branches of science.

There have been attempts, especially on the continent, to overcome this difficulty by the collaboration of several authors in the preparation of a text-book, and while it must be admitted that such a book may gain in precision, as it does in detail, yet these advantages must be in great measure offset by the lack of homogeneity from which such an effort must inevitably suffer. One even finds, in such productions, that the authors of different sections often express opinions diametrically opposed to one another. Out of a hundred readers of such a book, ninety-nine find themselves unable to form any definite opinions, while to the hundredth, himself an expert, the book is superfluous.

It is therefore a matter of the most urgent necessity to a subject like physiology that it be kept from falling to fragments, by being written up in an integrated fashion by a master hand. A book such as this serves, therefore, not only for the instruction of students, but also for the orienting of physiologists themselves in branches of their subject which they have not, by their research work, made peculiarly their own.

Aware of the magnitude of the task which the author has undertaken, we must therefore be prepared to over-

look small errors of omission or commission or partiality, which are inseparable from such works, and in doing so we gain much more than we lose, for we do not think that a better balanced text-book of physiology has ever been or could possibly be written. Although much new matter has been added, the bulk of the volume has been reduced by the deletion of a good deal of the organic chemistry which occupied space in former editions. Some of the chapters might with advantage have been extended a little in order to preserve the same treatment of detail throughout; thus, the chapters on the endocrine organs might well occupy twice their present space; as it stands at present, the physiology of the pituitary body, for example, occupies less space than, say, the general biology of nitrifying bacteria. But these are small cavillings, and we must feel grateful to the author for the splendid viewpoint of physiology which he has given us.

The chapter on the sense organs has been edited by Dr. H. Hartridge, and is excellently done; it is certainly an advantage to have this specialised chapter revised by one who has devoted particular attention to the subject, and the inclusion of this chapter in no way mars the continuity of the book. Many of Prof. Starling's colleagues have assisted him in the preparation of chapters dealing with subjects which they have made their own, and when we see how much of the matter incorporated in the book has emanated from the laboratories of University College, London, we feel how truly great has been the influence which Prof. Starling and his colleagues have exercised on the recent development of the science of physiology in Great Britain.

"Principles of Human Physiology" appeals most to those students who wish to get acquainted with the scientific side of physiology as it is to-day. The medical student who wishes to build a proper foundation for his clinical studies will be wise to choose it, and the science student working for a degree in physiology knows it to be indispensable; for physiologists themselves it is too well known to need further commendation.

An Australian Encyclopædia.

The Illustrated Australian Encyclopædia. Edited by Arthur Wilberforce Jose and Herbert James Carter. Vol. 1: A to Lys. Pp. x+768+26 plates. (Sydney, N.S.W.: Angus and Robertson, Ltd.; London: The Australian Book Co., 1925.) n.p.

THE first volume of an illustrated Australian encyclopædia, by Captain A. W. Jose, a well-known Australian journalist and historian, and Mr. H. G. Carter, president of the Linnean Society of New South Wales, forms an important addition to the reference books on Australia. The work was begun as an historical and biographical dictionary in 1912, but after the War it was resumed and enlarged by the inclusion of Australian science. The volume is illustrated by numerous text figures and a series of beautiful plates, of which ten are coloured, and show characteristic algæ, insects, birds, eggs, and reptiles.

Amongst the scientific articles in this first volume are those on the aborigines, in which Mr. S. H. Ray deals with the languages, Sir Baldwin Spencer with the customs and tribal organisation, and Dr. Ramsay Smith with the origin and physical character. Dr. Smith repudiates as baseless the view that the aborigines are mentally so primitive that they are unable to count up to more than four, as some uncivilised tribes have numerical names for children up to ten; they are very quick in mental arithmetic; and he says that the "ordinary black fellow is as good at figures as his white brother," that the aboriginal children at schools can be educated like white children and to the same extent, and that the "parents object to any distinction in the curriculum or the standard." Dr. Ramsay Smith says that it is now established that the Australians are a homogeneous race of Caucasian stock. Mr. Ray, though rejecting some of the claims for the affinities of the Australian and South Indian languages, remarks that the Dravidian and southern Australian are of the same morphological type.

The article on artesian water refers to the widespread decline in yield of the Australian wells, and the view that their discharge is due to gas pressure caused by the inflow of superheated plutonic water is noticed in terms which show that the theory is regarded more seriously in Australia than when it was put forward twenty years ago.

The article on flight traces the foundation of the modern aeroplane to the work of Hargraves, and quotes the prediction by Sir Richard Threlfall, in rebuke of its local neglect, that the time would come when Sydney would be less famous for its harbour than as "the home of Lawrence Hargraves, the inventor of human flight." Two of the more important articles are those on economic geography by Prof. Griffith Taylor, and on geology by Sir Edgeworth David and Prof. Cotton. In the latter article the glacial beds of Adelaide are said to be probably Proterozoic, but possibly Cambrian, and the term Permo-Carboniferous is retained mainly as a matter of custom, with full recognition that the beds in question are Permian. The article on irrigation describes many adventurous enterprises; that on the ballot recalls its first adoption in Australia and its original name of the Australian Ballot; and that on the Labour Movement is sympathetic, but does not bring the story later than 1915.

Birds of Eastern China.

A Handbook of the Birds of Eastern China (Chihli, Shantung, Kiangsu, Anhwei, Kiangsi, Chekiang, Fohkien and Kwantung Provinces). By J. D. D. La Touche. Part 1 (containing Families Corvidæ, Paridæ, Panuridæ, Sittidæ, Certhiidæ, Troglodytidæ, Paradoxornithidæ, Timaliidæ and Pycronotidæ. Part 2 (containing Families Cinclidæ, Turdidæ, Muscicapidæ and Laniidæ). Pp. 97-192 + plates 4-7. (London: Taylor and Francis, 1925.) 7*s.* 6*d.* net.

TWO parts of Mr. La Touche's work on the birds of Eastern China have now appeared, and if the standard set in these two parts is maintained, a long-felt want in ornithological circles will be admirably filled. Since the appearance of Oustalet's "Oiseaux de la Chine" in 1877, no book of any importance has been written on any of the larger areas of China, although a considerable amount of work has been done, and many authors, Ricketts, Styan, La Touche himself, Jones and Vaughan and other naturalists, have from time to time published articles in the *Ibis* and other ornithological journals. The author of the present work has adopted Stuart Baker's classification as given in the "Avifauna of British India"; a classification which will make it easy for readers of oriental ornithology.

In a work of this kind there are naturally certain minor points upon which all ornithologists may not be able to agree with the author, but it is obvious that he has bestowed so much thought upon his work and has drawn his conclusions with such care and deliberation that his decisions will always have to be examined with attention before being discarded. We notice that Mr. La Touche divides *Parus major* and *Parus cinereus* into two species, although he himself admits that the two grade into one another. On the other hand, in the second portion of his work, he treats *Turdus ruficollis* and *Turdus atrogularis* as races of one species, and quotes Stresemann to the effect that these two so-called sub-species hybridise.

The majority of Mr. La Touche's new forms have already been described in the *Bulletin of the British Ornithologists' Union*. In Part 1 we have *Pyctorhis sinensis major* and *Pycnotus sinensis stresemanni*, whilst in Part 2 we have *Cynclus pallasii wilderi* and *Hemichelidon sibirica incerta*, but we would note that the types of these sub-species has not been recorded.

When we come to the field notes, we find these to be very full and most interesting, due no doubt to Mr. La Touche's long and intimate knowledge of the countries harbouring the birds he discusses. So far, no map has been given of the localities treated, but we understand that one is to be given in Part 3 of this work, and such a map will add greatly to its value.

We may congratulate Mr. La Touche on having produced a work which is not only sound from a scientific point of view but is also one of great interest. No student of oriental ornithology but will welcome its appearance, and the chance of obtaining, at so moderate a price, so excellent a work.

Our Bookshelf.

Sampling and Testing of Highway Materials. By Prof. Wm. H. Barton, Jr., and Prof. Louis H. Doane. Pp. ix + 355. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

THE scope of this book is more extensive than its title would indicate, seeing that it includes a general treatment of cements, bricks, and aggregates, together with a variety of miscellaneous materials. The joint work of two American engineering professors, the treatment follows the usual lines of American laboratory manuals, the organisation of the testing-room being described with minutest detail and the various experiments outlined in routine form. The consequent 'cookery book' diction is necessarily pronounced; but, after all, the method pursued is possibly the best for those who are to perform the tests; while others, with laboratory experience in directing students, will appreciate the emphasis laid upon care and caution in conducting quasi-scientific tests in accordance with pseudo-empirical rules. In cement testing alone, this book will prove invaluable in the laboratories of the various colleges and departments, since it prescribes a number of tests additional to those usually recognised.

Of its nine chapters, the first three are devoted respectively to laboratory practice, sampling, and Portland cement and concrete. Even the specialist might benefit by perusal of these. Comparatively little has yet been attempted in Great Britain in regard to the standardisation of tests for hardness, abrasion resistance, toughness, etc., of stones. Chap. v. appears to lack scope and system in dealing with miscellaneous materials, but these deficiencies are compensated for to a great extent by the treatment of bituminous materials in the succeeding chapter.

The thirty-six pages of Chap. vii. are devoted to specifications, mainly in accordance with the requirements of the American Society for Testing Materials. The collection of diagrams and tables in Chap. viii. affords a useful appendix to the book. Nine diagrams, showing the effects of various factors on the strength of concrete, are included, while, additional to a number in the text, twenty-five useful tables are given of a type rarely found in text-books. A concluding chapter, "Subgrade Soils," is by Mr. J. R. Boyd, Assistant Engineer of Tests, U.S. Bureau of Public Roads, Washington.

The History of Protozoology: Two Lectures delivered before the University of London at King's College in May 1925. By Prof. F. J. Cole. Pp. 64 + 2 plates. (London: University of London Press, Ltd., 1926.)

THIS little volume is based on two lectures delivered by Prof. Cole at King's College, London, in 1925. It is impossible in the small amount of space at the

author's disposal to give more than a brief outline of the more important events in the history of protozoology; but it must not be assumed on this account that this has become a mere recital of dates and names. Far from it. By means of a judicious selection of the more important events in protozoological discovery and by the neglect of all matter of a controversial nature, Prof. Cole has prepared a very readable book which gives a much-needed sense of perspective to a branch of science which has been so very rapid in its growth. He emphasises the difficulties under which the pioneers worked and shows that we cannot appreciate them at their true value unless we rid ourselves of our modern bias. He illustrates "not only the importance of success, but the significance of failure. In criticising our predecessors, we must not forget that we stand on their shoulders and that we owe as much to their errors as to their wisdom."

Commencing with Leeuwenhoek, the "Father of Protozoology," the more important discoveries are indicated and their importance shown. The greater amount of space is given to the work of the past century—an era when so many brilliant discoveries in the medical and economic fields were made. The whole of the science is covered, however, not merely the economic sides, and an extensive bibliography is appended by means of which the student is encouraged to pursue further the subject to which this forms such an interesting introduction.

Air Ministry: Meteorological Office. The Meteorological Observer's Handbook. Approved for the Use of Observers by the Meteorological Office and the Royal Meteorological Society. 1926 edition. (M.O. 191.) Pp. viii + 136 + 36 plates. (London: H.M. Stationery Office, 1926.) 5*s.* net.

THIS work is of interest to all meteorologists without distinction of the branch of weather study in which they are concerned, and its essentials are as necessary to trained physicists as to the more ordinary observer whose work is somewhat empirical. The necessity for uniformity of practice has been kept well in view, and with regard to temperature and rainfall, details as to position and exposure are of primary importance. The decisions of international conferences are adhered to so far as practicable.

Instructions are given for making observations of the several elements, except that observations of the free atmosphere are not dealt with, this information being contained in other publications. There are copious illustrations of autographic instruments, and details are given for their management. There are also complete tables for the manipulation and correction of the various observations. With many elements where diurnal variation is concerned, summer time has to be disregarded so far as is practicable by the observer or most important defects would be the result of observation. Notes of important action should be carefully entered in the permanent register.

A new section on visibility, of special importance for navigation on the sea or in the air, has been introduced, and by its aid good observations can be made either by day or night. A number of cloud pictures are given, and the excellent representations will enable an observer to identify the various cloud forms. A study of the work cannot fail to interest an observer.

(1) *A First Course in Statistical Method.* By Prof. G. Irving Gavett. Pp. vii + 358. (New York: McGraw Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 17*s.* 6*d.* net.

(2) *Mathematics of Life Insurance.* By Prof. L. Wayland Dowling. (Modern Mathematical Texts.) Pp. x + 121. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 8*s.* 9*d.* net.

HAND in hand with the boom in industry in the United States there has been a continued spate of text-books on statistics, life insurance, and the mathematics of finance generally. The mathematical knowledge required to master these books, generally speaking, does not extend beyond elementary algebra, mainly permutations and combinations, and sometimes, but not always, a knowledge of differentiation. In the first of the above works, for example, there is a special appendix on "Derivatives and Integrals" expounding a great deal less than is known by the average schoolboy just entering a university course in Great Britain. Yet the scope of the work includes frequency, dispersion, skewness, probable error, curve-fitting, correlation and regression. It means, of course, that no time is wasted in arguing with the reader; he is just told. If he is not satisfied with this, he will find in these works numerous illustrations in which it *is* so.

The second of these books should be of value to those desiring to master the methods of calculation adopted in the many forms of insurance. It is really a book on arithmetic and algebra applied in a stimulating manner to an interesting series of special problems, and is very readable. Both works are well produced.

The Journal of the Institute of Metals. Volume 34. Edited by G. Shaw Scott. Pp. 799 + xi + 33 plates. (London: Institute of Metals, 1925.) 31*s.* 6*d.* net.

METALLOGRAPHIC studies of alloys of the non-ferrous metals occupy a large part of the present volume, and it is satisfactory to observe that in this field of research England takes the leading place. Such an investigation as that of Drs. Hanson and Gayler on the ternary alloys of aluminium, copper and zinc, with its extraordinarily complex equilibria, shows to what perfection the methods of study in this field have been brought. Two quite independent investigations deal with the β-brasses and their transformation at 470°, both arriving at the conclusion that a eutectoid is not formed, and that the transformation is one which is not accompanied by any change of structure. The copper-tin and copper-cadmium alloys are also studied. Two papers are concerned with the influence of time in tensile tests conducted at high temperatures, this being now a matter of technical importance, on account of the need for metals which can withstand continuous loading at high temperatures. A note on the copper objects of the American Indians before the arrival of the Spaniards will be of interest to archæologists. The objects are of pure material, apparently Lake Superior native copper. More than half of the volume is occupied by abstracts, the literature relating to non-ferrous metals having now been brought up-to-date, and covering a very wide field. This work is remarkably well done, and is worth consulting by others than metallurgists, on account of the large quantity of data brought together from many sources.

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.*]

Spinning Electrons.

I UNDERSTAND that in the newly proposed spinning electron the periphery is supposed to move faster than light, and the question has arisen in some minds whether such a motion can be allowed by the relativity theory. I think an assurance can be given that the relativity theory raises no objection.

It must be remembered that the mass and energy of an electron are considered to reside in the electromagnetic field outside its boundary. Whether the electron spins or not, this field is steady, so that there is no question of any transport of mass or energy with speed faster than light. It is only when *energy* or *signals* are alleged to go faster than light that the relativity theory is moved to intervene. Further, the spinning electron represents a state of the world—distribution of charge-and-current vector—which, while differing from that of an electron at rest, is nevertheless equally static and unchanging. It seems almost an abuse of language to apply the term velocity in connexion with a structure which is perfectly stationary; but the description in terms of spin may be held to serve its purpose since it leaves no doubt as to the structure intended.

The mathematical definition of velocity (dx/dt) contains no special reference to motion in a dynamical sense; x is merely the co-ordinate of a selected succession of world-points, and there is in the definition no guarantee that dx is traversed by anything except the thought of the mathematician. In describing the electron as spinning, what happens is that, faced with a hitherto unimagined structure, we make our thought skip faster than light round its boundary, and by so doing succeed in seeing a correlation with a more familiar structure, namely, that of an electron at rest. The correlating velocity has no more physical existence than has the factor $\sqrt{-1}$ used to correlate the structure of the four-dimensional world to the more familiar structure of a four-dimensional Euclidean space. In a deeper analysis we should not speak of a moving charge-element but of a charge-and-current vector, motion being attributable only to boundaries or analogous features of charge distribution—not to *charge*, but to *a charge*. When in the cruder description the charge moves faster than light, the charge-and-current vector J^μ becomes *space-like*. (In ordinary macroscopic phenomena J^μ is always *time-like*.)

It may be interesting to recall that the conclusion that the electron contains a space-like J^μ was already reached tentatively from a study of the interrelation of the electromagnetic and gravitational fields (see my "Mathematical Theory of Relativity," p. 211). It is deduced from Weyl's action-principle. So far as I can make out, Weyl himself reached a different conclusion, but it seems a straightforward result from his theory. From the action-principle a formula was obtained connecting mass-density with the electric vector ($\rho_0 = -(\beta^2/12\pi) J^\mu J^\mu$) and the conclusion was—"Since the density of matter is always positive, the electric charge-and-current inside an electron must be a *space-like* vector, the square of its length being negative. It would seem to follow that the electron cannot be built up of elementary electrostatic charges but resolves itself into something more akin to magnetic charges." A. S. EDDINGTON.

Observatory, Cambridge,
April 24.

I FEEL that there are serious arguments against the two objections raised by Mr. Kronig (NATURE, April 17, p. 550) to the view that the electrons in the atom possess an inherent magnetic moment, a view which Uhlenbeck and Goudsmit have shown to have important spectroscopic consequences. I will consider first the second objection, which seems to me to involve implicit assumptions about the structure of the atomic nucleus which go far beyond our present knowledge of the facts or even of the probabilities. I am prepared to follow Mr. Kronig to the extent of believing that if an electron has a quantised spin when in a Bohr orbit, an electron which has the privilege of taking part in the building up of an atomic nucleus will have the same property of possessing one or more units of angular momentum or of magnetic moment. But it seems to me improbable that the electron after it has entered into the composition of the nucleus will be able, as an individual electron, to retain this angular momentum. The 'dimensions' of the nucleus are not very much greater than those of an electron, and as the nucleus may contain a very considerable number of electrons and protons, it must be a highly interlocked structure of a kind which scarcely seems likely to afford opportunity for the ordered spinning contemplated.

I suggest that what is more likely to happen is that the electron gets rid of this angular momentum in the process of nucleus formation either by passing it on to the nucleus as a whole or else by radiating it away. If the angular momentum is transferred to the nucleus as a whole, its magnetic effect becomes negligible owing to the much higher moment of inertia of the rotator; so that in either event the nucleus would have no appreciable magnetic moment. That the nucleus as a whole does possess a quantised angular momentum is shown by the mechanical gyromagnetic anomaly, as I showed in 1922 (*Roy. Soc. Proc.*, A, vol. 102, p. 538), and also, though less directly, by the corresponding and similar spectroscopic anomaly. In any event the magnitude of the mechanical gyromagnetic anomaly makes it necessary to admit the existence of a quantised spin of the nucleus, a structure the 'dimensions' of which are not much greater than those of an electron.

As regards the first objection, the statement as to the foundation of the Bohr magneton resting on the orbital motions of electrons which can be treated solely as point charges moving with velocities small compared with that of light, seems to be too narrow. If it is assumed that an electron is a sphere of radius R carrying a charge e and that the inertia is entirely electromagnetic (these are the simplest assumptions which can be made), the application of the quantum condition $\int pdq = nh$, where p is the angular momentum, requires that for any rotation the magnetic moment of a spinning electron should be $n \cdot eh/4\pi cm$ where n is an integer and the other factor is the magnitude of the 'Bohr magneton.' O. W. RICHARDSON.

King's College,
Strand, W.C.2.
April 19.

IN view of the letters recently published in NATURE upon the subject of rotating electrons, it may be of interest to mention some attempts made four years ago to use this idea in explaining the stability of the nucleus. It is common knowledge that the fact that

nuclei can exist despite their excess positive charge cannot be explained without introducing hypotheses outside the classical electrodynamics. Whilst the electrostatic attractions which would lead to collapse of matter may be balanced by the centrifugal acceleration of the particles on stationary quantised orbits, no inertia effect can compensate the electrostatic repulsion which should lead to the explosion of the nucleus.

The idea, which was not pursued as it did not seem susceptible of quantitative examination, was to assume that protons and electrons are rotating at speeds given by the usual quantum condition. It is at once evident that one cannot go very much further without making some arbitrary assumption—

1. About the distribution of electricity and mass in the proton or electron, if indeed either term has any meaning when referred to part only of a particle.
2. About the force holding the proton or electron together if the parts repel one another as they would if the ordinary laws of electrodynamics apply to them.
3. About the magnetic field of a rotating proton or electron.

This much, however, is clear, that if the effective radii are of the order usually assumed, the peripheral speed would in either case approach the velocity of light and that the peripheral speed of the proton would approach it somewhat more closely than that of the electron. If anything like the ordinary laws hold, this means that protons and electrons will have intense magnetic fields, almost, but not quite balancing their electrostatic fields at distances of the order of their radii, the magnetic field of the proton being somewhat greater than that of the electron. At greater distances, of course, the magnetic forces would disappear compared to the electrostatic forces, since their value decreases more rapidly than with the square of the distance.

With such particles it is clear that stable nuclei can be built up, for the magnetic forces can be arranged all to support cohesion, whilst, of course, only the excess positive charge is available to cause disruption. Since the positive particle with its greater mass has the greater peripheral speed and magnetic field, an excess positive charge can be accommodated. It is possible to make fairly plausible assumptions which explain the stability of the simpler nuclei, but as it is impossible to base them upon any exact calculation without making hypotheses about the internal forces, they are scarcely worth recording.

F. A. LINDEMANN.

Clarendon Laboratory,
Oxford, April 23.

IN a recent letter to NATURE (February 20, p. 264), Messrs. Uhlenbeck and Goudsmit have shown how the theory of the spinning quantised electron can be applied to the problem of the multiplet structure of spectral lines and that of the anomalous Zeeman effect. In both cases the theory gives excellent results, if the ratio m/M of the magnetic moment to the mechanical one is identified with the corresponding ratio for the orbital motion ($e/2cm_0$, where e is the charge and m_0 the mass of the electron) in the former case, and to the double of it in the latter.

The following is a brief account of a solution of this paradox on the basis of the special relativity theory (the fuller publication being reserved for the *Zeitschrift für Physik*).[1]

[1] This question has been already treated on different lines by Dr. Thomas, of Copenhagen. I am indebted to Dr. W. Pauli for the possibility of taking notice of Dr. Thomas' paper before it was published, and also for valuable suggestions in the course of my own investigation.

Without entering into the consideration of the spinning motion of the electron and into speculations about its 'inner structure,' we shall treat it merely as a point, associated with a vector $\mathbf{m}$, corresponding to the magnetic moment, and possessing a mechanical moment $\mathbf{M}=\frac{1}{\kappa}\mathbf{m}$. From the point of view of the relativity theory, a three-dimensional vector quantity must be considered as the space part either of a four-dimensional vector with four components or of an antisymmetrical tensor with six components. Now, the magnetic intensity $\mathbf{H}$ represents, as is well known, the space part of the electromagnetic field antisymmetrical tensor $F_{\alpha\beta}=-F_{\beta\alpha}$ ($\alpha,\beta=1,2,3,4$) the 'time part' of which corresponds to the electric intensity $\mathbf{E}$, according to the Minkowski substitution:

$$\begin{pmatrix} F_{23}, & F_{31}, & F_{12}, & F_{14}, & F_{24}, & F_{34} \\ H_1, & H_2, & H_3, & -iE_1, & -iE_2, & -iE_3 \end{pmatrix}.$$

It appears necessary, therefore, to introduce as the four-dimensional extension of $\mathbf{m}$ an antisymmetrical 'moment tensor' $\mu_{\alpha\beta}=-\mu_{\beta\alpha}$:

$$\begin{pmatrix} \mu_{23}, & \mu_{31}, & \mu_{12}, & \mu_{14}, & \mu_{24}, & \mu_{34} \\ m_1, & m_2, & m_3, & ip_1, & ip_2, & ip_3 \end{pmatrix},$$

the 'time part' $\mathbf{p}$ of which is a three-dimensional vector analogous to the electrical moment of a dipole.

The corresponding extensions for the three-dimensional magnetic energy $-\mathbf{m}.\mathbf{H}$ and torque $\mathbf{m}\times\mathbf{H}$ with components $m_\alpha H_\beta - m_\beta H_\alpha$ are then easily seen to be $U=-\frac{1}{2}\mu_{\alpha\beta}H_{\alpha\beta}$ (the summation sign for equal index-pairs being omitted), and $f_{\alpha\beta}=m_{\alpha\gamma}F_{\beta\gamma}-m_{\beta\gamma}F_{\alpha\gamma}$. Denoting the electron's 'proper time' with τ, we then get the following equations for the 'spinning motion,' that is, the rate of change of $M_{\alpha\beta}$:

$$\frac{1}{\kappa}\frac{d\mu_{\alpha\beta}}{d\tau}=\mu_{\alpha\gamma}F_{\beta\gamma}-\mu_{\beta\gamma}F_{\alpha\gamma}, \quad . \quad . \quad . \quad (1)$$

which are equivalent to

$$\frac{1}{\kappa}\frac{d\mathbf{m}}{d\tau}=\mathbf{m}\times\mathbf{H}+\mathbf{p}\times\mathbf{E}, \quad \frac{1}{\kappa}\frac{d\mathbf{p}}{d\tau}=\mathbf{p}\times\mathbf{H}-\mathbf{m}\times\mathbf{E}. \quad (2)$$

These equations are, however, strictly valid in that case only, when no *a priori* relation between $\mathbf{m}$ and $\mathbf{p}$ exists. In the case under consideration these vectors are connected with each other by the invariant relation

$$\mu_{\alpha\beta}\dot{x}_\beta=0 \quad \left(\dot{x}_\beta=\frac{dx_\beta}{d\tau}\right), \quad . \quad . \quad . \quad (3)$$

that is

$$\mathbf{p}=\frac{1}{c}\mathbf{v}\times\mathbf{m}, \quad . \quad . \quad . \quad . \quad (4)$$

expressing the fact—or rather the *assumption*—that in a co-ordinate system, in which the electron's translational velocity $\mathbf{v}$ is zero, the 'electrical moment' $\mathbf{p}$ must vanish. In order to account for this restriction one must replace the energy function U by $U'=-\frac{1}{2}\mu_{\alpha\beta}F_{\alpha\beta}-A_\alpha\mu_{\alpha\beta}\dot{x}_\beta$, where A_α are the components of an indefinite vector multiplier, and accordingly replace the equation (1) by

$$\frac{1}{\varkappa}\frac{d\mu_{\alpha\beta}}{d\tau}=\mu_{\alpha\gamma}F_{\beta\gamma}-\mu_{\beta\gamma}F_{\alpha\gamma}+A_\gamma(\dot{x}_\alpha\mu_{\beta\gamma}-\dot{x}_\beta\mu_{\alpha\gamma}). \quad (5)$$

By means of the relation (3) and $\dot{x}_\alpha\dot{x}_\alpha=-c^2$ the following expression is found for A_γ:

$$A_\gamma=\frac{1}{\varkappa c^2}(\varkappa F_{\gamma\beta}\dot{x}_\beta-\ddot{x}_\gamma). \quad . \quad . \quad . \quad (6)$$

A more rigorous deduction of these equations, as well as of the corresponding equation for the translatory motion of the spinning electron, is achieved by means of the Hamiltonian principle $\delta\int L d\tau=0$, with

the two accessory conditions $\dot{x}_\alpha^2 = -c^2$ and $\mu_{\alpha\beta}\dot{x}_\beta = 0$, the Lagrangian function having the form $L = \frac{1}{c}\phi_\alpha \dot{x}_\alpha + T + \frac{1}{2}\mu_{\alpha\beta}F_{\alpha\beta}$, where ϕ_α is the electromagnetic potential and T the 'kinetic energy' of the electron's spin. This quantity as well as $\mu_{\alpha\beta}$ must be regarded as functions of the 'angular velocity' $\omega_{\alpha\beta} = -\omega_{\beta\alpha}$, their variations being expressed by $\delta T = \frac{1}{2\kappa}\mu_{\alpha\beta}\delta\omega_{\alpha\beta}$ and $\delta\mu_{\alpha\beta} = \mu_{\alpha\gamma}\delta\Omega_{\gamma\beta} - \mu_{\beta\gamma}\delta\Omega_{\gamma\alpha}$ $(d\Omega_{\alpha\beta} = \omega_{\alpha\beta}dt)$.

Omitting the deduction (which will be found in my *Z. f. Phys.* paper), I shall give here but the final equations, which are (5), (6) and

$$\frac{d}{d\tau}(\lambda\dot{x}_\alpha + A_\beta\mu_{\beta\alpha}) = \frac{e}{c}F_{\alpha\beta}\dot{x}_\beta + \tfrac{1}{2}\mu_{\beta\gamma}\frac{\partial F_{\beta\gamma}}{\partial x_\alpha}, \quad . \quad (7)$$

where the factor λ differs very little from the 'rest-mass' m_0:

$$\lambda = m_0 + \frac{U}{c^2} = m_0 - \frac{1}{2c^2}\mu_{\alpha\beta}F_{\alpha\beta}. \quad . \quad . \quad (8)$$

By applying these equations to the motion of a spinning electron about a fixed nucleus, it appears possible to get *with the same value of the ratio,* $\kappa = m/M = \frac{e}{cm_0}$, a correct representation both of the multiplet structure and of the (anomalous) Zeeman effect. For example, in the absence of an external magnetic field ($H = 0$) we find from (5) the following approximate equation for the *secular variation* of $\mathbf{m}$:

$$\frac{1}{\kappa}\overline{\frac{d}{dt}\mathbf{m}} = \tfrac{1}{2}\mathbf{m} \times \overline{\left(\mathbf{E} \times \frac{\mathbf{v}}{c}\right)} = \tfrac{1}{2}\mathbf{m} \times \bar{\mathbf{H}}', \quad . \quad . \quad (9)$$

where $\mathbf{H}' = -\frac{\mathbf{v}}{c} \times \mathbf{E}$ is the mean magnetic intensity in a co-ordinate system where the electron is momentarily at rest (the mean being taken for the undisturbed orbital motion). This equation differs from that of Thomas by the fact that it refers to the *secular mean* and not to the true motion; it corresponds to an apparent ratio between the magnetic and mechanical moment of the electron's spin, which is exactly equal to one half of the actual one κ, that is, coincides with the corresponding ratio for the orbital motion.

J. FRENKEL.

Hamburg, March 25.

Transmission of Stimuli in Plants.

SNOW [1] has confirmed my discovery that the propagation of stimuli in the stem of the so-called Sensitive Plants is due to the transport of a hormone in the water of the tracheæ.[2] He, however, comes to the conclusion that in the leaves there is another and more rapid means of conduction of stimuli. This function he provisionally assigns to protoplasmic processes.

The idea that the same end is attained in the stem and in the leaves by two entirely different processes is difficult to accept. At the same time Bose's [3] view, which attributes the propagation of stimuli in both these organs alike to protoplasmic processes is negatived by the experiments of MacDougal, Cunningham,[4] and myself. In my own experiments especially it was rigorously proved that propagation took place across zones in which there were no living elements. Bose's statement that he cannot repeat my experiments, which were contrary to his own conclusions, may be put aside, inasmuch as my results have been confirmed by Snow and others.[5]

It is true that my experiments were principally carried out on stems. Nevertheless, two series were carried out with leaves, and proved conclusively that in these organs also the propagation of stimuli is due to the transport of hormones in the water of the tracheæ. However, when Snow brought forward new facts and interpreted them in support of his view that there are two distinct means of propagation, I determined to make a further study of the matter, as I thought it of the highest biological importance to determine whether the propagation of stimuli in plants took place by a means comparable to nervous transmission in animals, or whether it is simply and solely due to the transport of hormones.

My complete work on this subject will not be ready for publication for some time. Consequently, this is a short account of my experimental results without critical discussion. Meanwhile, I would merely state that the cohesion theory of Dixon and Joly appears to me to afford the explanation of the water movements which cause the propagation of stimuli.[6]

In 1924 I carried out the following experiments: I stripped the middle region of the pinnæ of a leaf of *Mimosa spegazzinii* of a number of its pinnules, leaving only about six pairs at the base and six at the apex. On the intact pinna there were about thirty pairs. Then one of the pinnæ was cut off and supported obliquely in a vessel of water close by the pinna still attached to the plant. When the remaining pinnules of each pinna had reopened I applied a small heat stimulus to the apical pinnules. The basal pinnules of the attached pinna quickly closed, and the stimulus often passed on to other leaves, but in the severed pinna the basal pinnules did not close, although the applied stimulus was no less; indeed, it was often intentionally greater. Similar results were obtained with *Mimosa pudica*.

Last summer I made experiments on the basipetal propagation of stimuli through a region of a petiole which had been killed. A jet of steam applied for about 10 or 15 minutes was used to kill a length of 5 mm. of the petiole. After the pinnules had reopened, a stimulus was applied by burning the apical third of a pinna—sometimes somewhat more. In every case the stimulus was transmitted to the primary pulvinus and nearly always could be traced beyond that by the responses of other leaves. Snow, who failed to get this result, assigns the success of Haberland [7] and Fitting [8] in similar experiments to the transport of sap from the killed cells, and considers this type of transmission quite different from that occurring in normal leaves. This interpretation is negatived when one compares the velocities found in normal leaves, which have been selected as being as similar as possible to the experimental leaves. In the first column of the following table are shown the velocities (in cm. per min.) of propagation in these experimental leaves compared with the velocities observed in the similar normal leaves. In the second column the velocities of propagation of the stimulus in the stem after it had passed from the killed portion of the petiole, compared with that observed in the stem supporting the normal control leaf, are entered.

[1] *Proc. R.S.*, B, 1924, vol. 96, p. 349; 1925, vol. 98, p. 188; NATURE, 1925, vol. 115, p. 82.
[2] *N. Giorn. Bot. Ital.*, 1916, vol. 23, p. 51; résumé in *Arch. Ital. de Biol.*, 1916, vol. 65, p. 219.
[3] NATURE, 1925, vol. 116, p. 376; *Proc. R.S.*, B, 1925, vol. 98, p. 290.
[4] *Bot. Gaz.*, 1896, vol. 22, pp. 296, 297.
[5] *Beitr. z. allg. Bot.*, 1923, vol. 2, pp. 260-262; *Zeitschr. f. Bot.*, 1925, vol. 17, p. 260 and p. 261. I am informed that, also in Oxford, the passage of a stimulus across an organic discontinuity in the stem has been demonstrated.
[6] NATURE, 1924, vol. 114, p. 626.
[7] "Das reizleitende Gewebesystem der Sinnpflanze," 1890, p. 36.
[8] *Jahrb. f. wiss. Bot.*, 1904, vol. 39, p. 511.

TABLE.

	Velocities in Leaf.	Velocities in Stem.
Experimental Plants .	93, 75, 48, 65, 90	9, 3, 3, 3, 15
Normal Controls . .	96, 102, 80, 110, 160	6, 4·5, 6, 7·8, 24

Here it is evident that the velocity in the experimental and normal leaves are of the same order, while those observed in the stem are much smaller. This difference finds full explanation in the difference of the cross-section of the conducting wood in the two organs. The fact that the velocity in the leaves having killed zones in the petioles is generally less than that observed in the normal ones may be explained as due to changes brought about in the wood by the application of the steam. Probably the most important of these changes is the development of water vapour in some of the tracheæ.

Snow found that the velocity with which colouring matters rise in the stem corresponds fairly with that of the propagation of stimuli. Last autumn I also carried out similar experiments with *M. spegazzinii*, making use of eosin. When cut branches are transferred from water into a solution of that dye, the colouring matter rising in the stem acts, in most cases, as a stimulus, and it is possible to follow its rise by the consecutive fall of the leaves from the base to the apex of the stem. In a dozen cases immediately as a pulvinus responded I cut it across and found the eosin already arrived. This method is not applicable to tertiary pulvini, which are in general less sensitive to eosin. In order to meet this difficulty, I added a good stimulant (an extract of the long shoots of *Stigmatophyllum littorale*) to the eosin solution, making up the concentration of the latter to 5 per cent. This solution was applied to the cut end of a branch, and usually the lowest leaf of this branch was the subject of these observations. As soon as the topmost pinnules of a pinna of this leaf had closed, I cut off the terminal portion (4-10 mm.) of its rachis with a scissors and examined it to see if the colouring matter had reached it. At the same time stop-watch observations gave the velocities of the propagation in the stem, the leaf, and the pinna. The results showed clearly that the stimulus is transmitted, alike in the stem and the leaf, by means of the water current. Out of 37 experiments, in one only was the eosin not found in the tip of the pinna. In all the other 36 cases a simple lens was sufficient to show the eosin on the cut surface of the apex of the pinna. Among these there were cases in which the pinnules from the base to the apex closed in 5, 4, $3\frac{1}{2}$, $2\frac{1}{2}$, 2 min. In these cases, whether one applies cutting or heating as the stimulus, the tension previously existing in the water of the conducting tracts must disappear owing to the rapid motion of the liquid. The neutralisation of the tension must follow the immission into the waterways of the sap of the responding cells, namely, those of the tertiary pulvini of the pinnules which close one after the other. The coloured liquid containing the hormone is present effectively in the tracheæ of the leaves even beyond the level of the motor organs which have responded, as other experiments demonstrated to me; and, in certain cases at least, the sap expelled by the responding pulvini, containing in all probability the hormone, helps in the propagation of the stimulus.

In another set of experiments I bent down a piece of a branch supporting a leaf into a shallow vessel of eosin solution. I then cut across the petiole under the liquid. At the moment of the closing of the topmost pinnule, I cut off a small apical portion (4-8 mm.) from its rachis. Of 12 such experiments, 11 showed the eosin present in the cut surface of the apical region. For this experiment I used a more concentrated eosin solution to allow for dilution caused by the exudation from the cut 'Schlauchzellen.'

In other experiments I bent down the tip of a leaf very gently into a solution of eosin and then cut it while submerged. Microscopic examination then showed that the eosin arrived at the base of the last pinnules as they closed. Sometimes the presence of the dye in the transverse section of the rachis of the pinna might be observed with a simple lens, but sometimes it required a compound microscope to reveal it. By using a more concentrated eosin solution (30 parts in 100) it was possible, in nearly every case, to demonstrate that the eosin arrived simultaneously with the stimulus, at the bases of the pinnules of the adjoining pinna.

UBALDO RICCA.

Genoa, Italy.

Experiments in the Shaping of Wood with Flint Implements.

THE discovery (NATURE, January 9, 1926) made during my archæological excavations in 1925 of an ancient wooden structure, induced me to carry out some experiments in the shaping of wood with flint implements. So far as I can ascertain, this matter has not been investigated extensively, and the results of my work may therefore be of some interest. The flint implements used in these experiments were flaked by me with a quartzite hammer-stone, and comprise —an axe (Fig. 1, B), planes (Fig. 1, A and D), a pointed specimen (Fig. 1, C), and a flake with thick

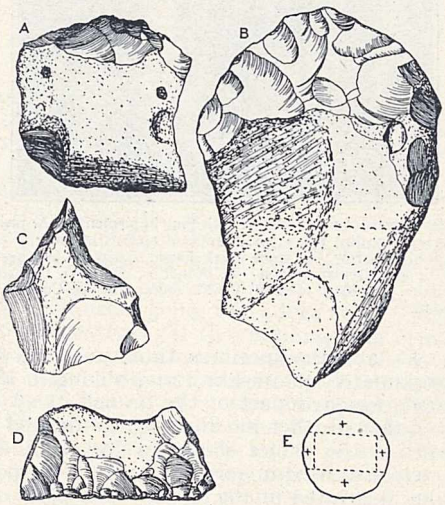

FIG. 1.—Flint implements made by Mr. J. Reid Moir and used in the experiments described. A and D, planes; B, axe which was shafted along the dotted line; C, point used for boring; E, section of branch from which specimen shown in Fig. 2, C, was formed; the continuous and dotted lines, enclosing crosses, indicate the four pieces which were split off the original branch. Reduced to $\frac{1}{3}$.

back, and more or less straight cutting edge. The axe was mounted [1] along the dotted line shown in Fig. 1, B, in a split stick about two feet in length, and I found that with this weapon I could detach branches up to three inches in diameter from trees without any great difficulty. The axe is flaked on one side only. On the side not figured, unflaked

[1] The stone was kept in position by string tightly bound round the split portions of the stick.

cortex is present, but this fact made, apparently, little or no difference to the cutting powers of the edge.

The specimen shown in Fig. 2, B, is part of the branch of an apple tree which was detached with the axe described, and shaped roughly to the form of a pointed stake, such as was found supporting the wooden structure above mentioned (NATURE, January 9, 1926). It will be remembered that this structure was formed of two pieces of oak, of plank-like form, evidently split off from a trunk of considerable size, and I was anxious, therefore, to see if it were possible to produce, with flint implements, a piece of wood of plank-like form, from a branch with a more or less rounded section. The result of my attempt to do this is illustrated in Fig. 2, C, and it will be seen that I was successful in my efforts. The branch was first of all split longitudinally four times with the axe, so that the outer, rounded surface was removed

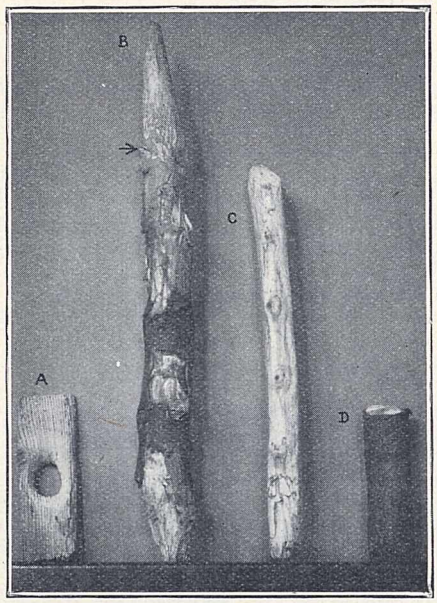

FIG. 2.—Specimens of wood shaped with flint implements. A, piece of deal perforated by flint point; B, branch of apple tree pointed—note cut indicated by arrow; C, apple wood shaped to a plank-like form from a more or less circular branch; D, branch of elm sawn through with a flint flake. Reduced to about ⅛. Photograph by the Curator, Ipswich Museum.

(Fig. 1, E), and the specimen thus caused to assume an approximately plank-like form, oblong in section. The wood, which is part of the branch of an apple-tree, was then further modified to the desired shape by means of the planes shown in Fig. 1, A and D, which were also used in smoothing down the point of the stake illustrated in Fig. 2, B. The piece of deal (Fig. 2, A) was perforated by means of the pointed implement (Fig. 1, C), the operation being carried out from both sides of the wood alternately, while the specimen shown in Fig. 2, D, represents a branch of an elm tree which was sawn through with a flint flake, the cutting edge of which I did not provide with 'teeth.' With the exception of the axe, which was mounted, all the other flint implements were held in the hand when in use.

The simple experiments I have been able to carry out have convinced me that with suitably shaped flint implements it is possible to do most things in the rough shaping of wood that can be done with steel tools. Further, it appears to me at present very difficult to distinguish, in the majority of cases, between wood thus cut by flints, and that which has been roughly shaped by steel. In this regard I would direct attention to the cut (indicated by an arrow) in Fig. 2, B, and resulting from a blow with the flint axe (Fig. 1, B). This incision is, however, so narrow and 'clean' that I cannot see how it is possible to differentiate between it and a cut produced by a sharp steel hatchet. I found that the shaping of these pieces of wood, though not actually difficult, was nevertheless a very slow process, as may be judged from the fact that it took me about half an hour to perforate the piece of deal shown in Fig. 2, A.

It would seem probable that prehistoric man, from the earliest times, utilised wood for making into implements and weapons, but it is only under exceptional geological conditions that any examples of this material would be preserved till the present day. The experiments I have carried out have demonstrated to me that very many of the ancient flint implements, referable to every phase of the Stone Age, which have been found, are admirably adapted for the shaping of wood and similar material, and I feel that these practically indestructible flint implements represent, as it were, merely the 'insoluble residue' of prehistoric industries, of which the other and more friable artifacts have disintegrated and disappeared during the great periods of time that have elapsed since they were made. If this surmise is correct, then the flint implements of ancient man give us, perhaps, but a very small and imperfect picture of his state of civilisation.

J. REID MOIR.
One House, Ipswich.

Relation of Weight to Height during Adolescence.

MY friend, Mr. D. Caradog Jones, who during his stay in Manchester was my collaborator in the anthropometric work which has been carried on at the Manchester Grammar School for so many years, has directed my attention to his contribution to NATURE of April 10, and has asked me to make some further comments. I gladly do so, partly as an acknowledgment of the help which he so unstintingly gave me and partly because I am also indebted to Prof. Dreyer for the interest he showed in 1921 in the work at the Grammar School, and the help I have gained from his numerous attempts to connect body measurements with accepted standards of body metabolism.

The formula to which Mr. Jones directs attention was first brought before my notice by Dr. James Kerr of the London School Board in 1911, when he was searching for a method of expressing mathematically the degree of nutrition of young children which was noticeable to the eye of the medical observer. Mr. Jones has applied this formula to adolescent children, among whom Livi claims that the result becomes constant for the 'mean' boy. It is, however, evident that the constant which Livi obtains is somewhat different from the constant obtained from the Grammar School boys. In studying the application of various formulæ I have felt to an increasing extent that the greatest difficulty in accepting any special one is due partly to the fact that the human body is built to do several entirely different kinds of work and that it develops therefore in a different way under different conditions. The apparent uniformity that is obtained by Livi's formula may be due to the fact that only two factors are taken into account, and that other factors, however essential to school anthropometry, are left out of account, particularly chest circumference, on which Dreyer himself lays stress in his "Assessment of Physical

Fitness," which affords information both of body build and respiratory reservoir.

I am by no means certain, however, that the physical framework and the mechanical output which fit a boy to be a long-distance runner is the same as those which fit him to be a good swimmer or a good gymnast, and there is good ground for believing that the good scholar in any given population is better, physically as well as mentally, than the poor scholar in the same population, but that this superiority may not be so manifest when we are dealing with another population. Even the accepted constant relation between body surface and body mass that is adopted for basal metabolism provides us with only a limited basis for judgment when we consider the metabolism of different forms of active life. We find that the area of the body surface, even as calculated from the mass, affords only a limited knowledge of the function of the skin and its capacity for heat radiation or the elimination of perspiration. All that one can hope from any of these formulæ is a basis for calculating variations in a particular population. They do not, I think, provide a standard of proper growth suitable for all conditions, nor do I think any uniform standard can be found applicable to all classes and races after adolescence is established.

So long ago as June 1899, NATURE published some very remarkable grading charts of a group of public school boys of an earlier generation by Mr. Cecil Hawkins, which enabled one to calculate the relative variations from the 'mean' of different boys in height, weight, and chest girth at successive ages. Graphs based on these illustrating special types of physical development were given in an article in the *School World* in August 1903. Mr. Hawkins' grading tables were in use at this school from 1909 until 1921, and have proved of inestimable value in studying the growth of individual boys in different directions. With the help of similar tables applicable to more recent conditions, but based on expected time increments of growth, which Mr. Jones has drawn up for Grammar School boys from figures calculated by Matthew Young, I have been able to compare the body build and the body metabolism as indicated by vital capacity of boys distinguished in different forms of athletic exercise, *e.g.* long-distance running, sprinting, swimming, gymnastic competition, high scholarship, and also a group of boys of retarded scholarship, and I think this method of comparative or composite graph affords us the basis for a convenient expression of our judgment of any particular boy. With the help of Dr. P. Brooke Mumford I am now organising at Manchester Grammar School schemes for the differentiation of the degree of development of the heat-eliminating powers and response of the skin to stimulation, and the relation of these powers to physical build and to output of activity. I hope to publish a complete statement of the anthropometric research done at the Grammar School since 1909 during the coming autumn.

ALFRED A. MUMFORD,
Medical Officer.

Grammar School, Manchester.

The Use of Arcs and other Fluctuating Sources in Photoelectric Photometry.

IN his paper on the registering microphotometer, P. P. Koch (*Annalen der Physik*, iv. 39, p. 705, 1912) describes an arrangement consisting of two similar photoelectric cells connected to an electrometer, both illuminated by the same source, but through different optical paths. The arrangement described has the advantage of being independent of intensity fluctuations in the source (provided that these are uniform over the area of the source), since the electrometer reading depends only upon the *ratio* of the intensities falling on the two cells. An example is given in which a change from 10 to 100 in the light intensity of the source produced only a 1 per cent. change in the electrometer deflexion. However, it remained impossible to use arcs, or other light sources which not only fluctuate in intensity but also flicker or change their position; for since the two beams come from different parts of the source, and traverse different optical paths, flickering changes the ratio of their intensities, as well as the absolute values.

It is the purpose of this note to point out that in most cases the optical paths to the two cells may be made practically identical by using a partially reflecting plane mirror to divide the beam. The arrangement is shown in the diagram below (Fig. 1). S is the source (a carbon or mercury arc, for example); the purpose of the lenses L and L' is obvious; TR represents an optical train of any kind (lenses, prisms, filters, polarisers, etc.); M is the partially reflecting plane mirror, C_1 and C_2 the two similar cells, and, before C_1, F, the filters, photographic plates, crystals, analysing nicols, etc., the variable transmission or absorption of which it is desired to measure. (The electrical connexions of the cells and the electrometer, etc., are not shown; they are described in detail by Koch, *l.c.*) Under these conditions flickering and wandering of the light source will alter both intensities in the same ratio, provided that the variable absorber F takes the

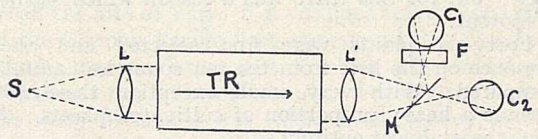

FIG. 1.

full beam of light; that is, requires no further diaphragms. This will be true, for example, in measuring the absorption of filters, large crystals, large areas of a photographic plate, etc.

If the variable absorber F requires a diaphragm, troubles may arise, due to the fact that fluctuations may change the distribution of energy over the cross-section of the beam of light. The intensity of the beam diaphragmed out may then change, whereas that of the full beam going to C_2 does not. There are then two alternatives: if the diaphragm in F may be removed some distance from the absorber, the dividing mirror M may be placed between the diaphragm and the absorber; but if, as in the microphotometry of spectral lines, the diaphragm must be very close to the object the transmission of which is to be measured, an attempt must be made to diaphragm the beam going to C_2 in an exactly similar manner, so that the two diaphragms or slits are situated at corresponding points of the cross-sections of the beams (which, fortunately, are themselves similar). How well this compensation will succeed depends on the fineness of the slits, on the optical system, and on the constancy of the light source.

The proper ratio for the intensities of the two beams is determined by the experimental conditions. It can be altered at will by interposing a uniform filter before either cell. One must of course take precautions to ensure that the variations in the intensity of the source are not too great. From Koch's data, and from results obtained in testing the present modification, variations of even several hundred per cent. are permissible.

Thus it is possible to use arcs and similar light sources giving high intensity in all regions of the spectrum for a large number of problems involving photoelectric photometry.

B. KURRELMEYER.
(National Research Fellow.)
Jefferson Physical Laboratory,
Harvard University,
March 27.

International Phenology.

THE list of thirty-one plants given in NATURE for March 20, p. 413, for which observations are requested, is singularly unfortunate for the British Isles, as fifteen are cultivated or alien; these, though four trees may be approved, are thus prejudiced for real scientific use.

It seems regrettable also that a list should be launched for scientific use that ignores botanical nomenclature and relegates a small letter to the specific or trivial name of those plants in which the former generic name is preserved; there are twelve such errors, besides two for insects.

F. A. BELLAMY.
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MR. F. A. BELLAMY'S letter directs attention to a point which might be considered a weakness in our selection of flowering plants for international phenology; but for this there was a reason which seemed prepotent.

Forty-six plants were first selected and their presence on the lists from the ten countries carefully compared. With very small exception these lists include a heavy proportion of cultivated plants. In one it was almost entirely so.

Of the eleven selected from the chief list in our own schedule (observed systematically for thirty-five years) there is only one, the horse chestnut. (By a printer's error its asterisk was transferred to the lilac.) Numbers 1 to 3 come in our supplementary list. Hence we felt compelled, in selecting the balance of seventeen, to consider our colleagues abroad by including ten further cultivated or alien kinds, making a total of fourteen out of the thirty-two.

The intentional omission of capital letters for all specific names, even where originally generic, was perhaps open to criticism. But is there not a growing tendency to adopt this simplification?

I am glad to have the opportunity of correcting an error in the reference to the "late" Prof. Vanderlinden in the letter in NATURE of March 20. Fortunately, Prof. Vanderlinden is still alive and active.

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Transfer of Excited Energy from Ozone to Hydrogen and Nitrogen.

RESULTS have been obtained by Venkataramaiah (*Jour. Am. Chem. Soc.*, 45, 261, 1923) which show that hydrogen is activated by continuous burning of oxygen in hydrogen. He considers that the reaction activates the hydrogen. Probably electrons of high kinetic energy, capable of ionising the hydrogen, are emitted by the reacting molecules. In considering this theory further it seems probable that ozone might play a part in this reaction as ozone is formed in flames, and also decomposing ozone emits radiation of very short wave-length as shown by Stuchety (*Zeit. w. Photochem.*, 19, 161, 1920). The energy corresponding to the radiation emitted is greater than the energy of ozone decomposition.

It has been shown by Grubb (NATURE, 111, 671, 1923), and Venkataramaiah (NATURE, 112, 57, 1923), that active hydrogen produced by electrolysis will combine with molecular nitrogen with the formation of ammonia. If ozone emits energy enough upon decomposing to activate the hydrogen, then in the presence of nitrogen we might expect that the active hydrogen would combine with nitrogen to form ammonia.

To test this, the following investigation was carried out. A solution of sulphuric acid, sp. gr. 1·213 at 15°, was electrolysed using a current of 6·2 amperes. The drop of potential across the electrodes was 9 volts. A piece of platinum foil 5 sq. cm. in area served as a cathode. The anode was a platinum wire 0·5 mm. in diameter and 35 mm. in length. A stream of ammonia-free hydrogen and nitrogen at atmospheric pressure, mixed approximately in the ratio of three to one respectively, and at a velocity close to eight litres per hour, was led directly down over the anode at which the ozonised oxygen evolved at a very rapid rate. The escaping gas mixture passed through a tube two feet long and was washed with ammonia-free water in an extremely efficient absorption bulb. Runs of fifteen minutes' duration were made. Then upon Nesslerising the absorbing liquid a heavy precipitate was obtained. To obtain a quantitative estimate an aliquot part of the absorbing liquid was taken for Nesslerisation. If the velocity of the hydrogen-nitrogen mixture was increased, less ammonia was formed. A further study is being made of some of the factors involved.

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Domestic Heating.

IT is curious that a lady of Dr. Marie Stopes's scientific eminence should not have taken more trouble to inform herself upon this subject before writing upon it in NATURE (March 6 and April 24). In the first place, the difference in tonnage of coal used in domestic fires (40 million) is not insignificant in relation to that used in industry (100 million), and in the second place (apart from Dr. Stopes's personal sensations) the radiant efficiencies of electric radiators, gas fires and coal fires are, according to Dr. Margaret Fishenden, in the ratio of 5 : 3 : 1. For my sitting-room I prefer to use coke, and in the bedroom gas fires or electric radiators, all of which are smokeless—a very desirable matter.

Low-temperature coke is not yet a commercial success though it may become so. Meantime, are we to continue to pour out literally many millions of tons of filthy soot into the atmosphere which cannot but affect the health of every town dweller because Dr. Stopes believes "a glowing coal fire gives out something subtle, yet intensely 'nourishing' to the system"?

J. B. COHEN.
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Headingley, Leeds,
April 24.

Radio Communication and Imperial Development.[1]

By Dr. W. H. ECCLES, F.R.S.

THE British Empire is a medley of fragments spread as if by blind chance over the habitable portions of the globe. Looked at in Mercator's projection, it is like a broken potsherd on the floor—a collection of large pieces and small pieces, at all distances apart. Yet, scattered as they are, these pieces of earth bear populations which instinctively turn to the mother country as the centre of that world which lies beyond their immediate interests. This is as true of the large pieces as of the small.

For so dispersed a family, the problem of telegraphic communication is important and difficult. Until the year 1902, long-distance telegrams were all carried by cables, under the sea or under the ground, and by wires on poles; and the task of serving sparsely populated and distant regions required capital outlay beyond reason. But between 1902 and 1904, in a series of bold experiments, Marconi proved that messages could be conveyed thousands of miles by telegraphy without wires. Then he and many others showed that electric waves can pass over mountain chains, and even far round the bend of the globe, at any rate at night, and that they could be picked up simultaneously in all directions round their source. Here obviously was a heaven-sent gift to the British Empire, for by wireless telegraphy we might now hope to communicate, simultaneously if desired, with a thousand places to which cables and wires could never be run.

Quite early in the development of wireless telegraphy, the principal nations began to apply it and to regulate its employment. Indeed, control was compelled, in the armed camp that Europe then was, by the consideration that, when war came, wireless would be useful to fleets and armies and dangerous in the hands of spies. In peace time, even, some degree of control was called for to reduce interference, especially between powerful long-range stations. Each such station ought, in fact, to transmit on a different wave-length from other stations; and once a wave-length is assigned to a particular long-range station, it should not be given to any other. In other words, the grant of a wave-length to a powerful station is equivalent to giving a right-of-way to that station. For all these reasons the Imperial Conference of 1911 declared that wireless communication within the British Empire should always be regulated with especial care, and that, in the main, the necessary stations should be State-owned and State-operated.

This decision being given, it only remained to erect the stations. In 1912 Parliament approved a contract which the Post Office had made with the Marconi Company for the erection of a British Imperial chain of six stations. This contract was, however, modified after a technical inquiry, and a new contract was ratified by the House of Commons in 1913. But the engineers had barely time to erect a few masts at Leafield in Oxfordshire and at Abu-Zabal near Cairo, when the contract was dissolved, principally on account of the advent of war. In contrast with our inaction, the United States had meanwhile pressed on with the construction of several large government stations, and France and Germany made great progress with their respective colonial plans. Perhaps we could afford to delay. Compared with Germany, for example, we possessed elaborate cable communications, and were more confident about defending them in every sea than Germany could be. But the result was that when war broke out in August 1914, no unit of the much-discussed British wireless chain had been erected.

Germany, on the contrary, had made great strides with her colonial communications between the years 1912 and 1914. She had established thoroughly modern stations in Togoland, in German East Africa, in German South-West Africa, and in the Pacific. The three African stations could inter-communicate with one another, and, to a limited extent, with the great station at Nauen, near Berlin. The Pacific station was at Yap in the Caroline Islands. It was a noteworthy coincidence that all these stations were completed just before the War began. I remember hearing the early trial signals from Yap while I was sailing across the Pacific in July 1914. No doubt this station was intended to receive instructions from Berlin, and retransmit them to island possessions, such as Apia in Samoa, and to naval and mercantile vessels in the Pacific and the China Seas. It may be of interest to recall the fate of Yap; it is wrapped up with the story of the German Pacific fleet commanded by Von Spee, which, months later, met Cradock at Coronel and Sturdee at the Falkland Islands. I remember some of the story because I was called from Sydney to Melbourne by the Australian Government to help in an advisory way with an interesting application of wireless. At this moment the German fleet was cruising to the north of Australia and was in nightly touch with Yap. As soon as this was observed, each of the small shore stations along the Australian coast was instructed to listen for the signals of the German fleet, to record the strength with which the signals were received, and to report daily to Melbourne. From these reports, by a process resembling triangulation, an estimate was made in Melbourne of the changes of position of the fleet. Meanwhile a British naval force had set forth with the object of destroying the wireless station at Yap. This was duly accomplished, and for days afterwards the Germans, unaware of the disaster, continued to call the dead station, in vain. These continued calls, by helping us to keep track of the fleet, eased the anxiety of those who knew that the New Zealand expedition was then well on its way to capture Samoa. Thus ends the story of Yap; that of the other German colonial stations was similar.

During the War our wireless energies were deflected from the building of great stations to producing relatively small outfits for fighting purposes. War telegrams were handled sufficiently well by the cables and the wireless stations of the Admiralty, and the War closed without any progress in imperial wireless. Meanwhile the French government had erected powerful stations at Nantes, Lyons and Paris, and smaller stations in their African territories; the Italian government had erected a large modern station at Rome;

[1] From a Friday evening discourse, entitled "Wireless in the Empire," delivered at the Royal Institution on April 30.

and the United States government had completed half-a-dozen big stations, together with a magnificent one near Bordeaux which was afterwards purchased by the French government. But the governments of the British Empire, at the close of the War, stood possessed of only one fairly large wireless station among them—that at Windhuk in German South-West Africa—captured by the forces of the Union of South Africa under General Smuts. Thus at the end of 1918 the British Empire was far behind most other great Powers as regards government-owned stations, and, by the way, equally far behind as regards powerful commercial stations.

At this time Lord Milner took up the cause of Imperial communications. Lord Milner appears to have been the only elder statesman of that day convinced of the imperial value of widespread communications, and aware of our national backwardness. But he looked for much more than mere duplication of cable- and land-line services. He envisaged the possibility of radiating daily from England and other great centres news and opinions of imperial interest in such a form that they could be picked up, perhaps after re-transmission by outpost stations, anywhere. He thought it wrong to continue to leave a large proportion of the population of the British Empire as isolated as if cast away on a raft in the ocean. I believe he thought that wireless would be as useful for the cultivation of mutual understanding as for strategy and commerce. In other words, he realised fully the importance of propaganda, and holding these views, advocated government expenditure on improving radio communications.

Within a year of the conclusion of the War, Lord Milner appointed a committee, under the chairmanship of Sir Henry Norman, to investigate afresh the problem of establishing a comprehensive wireless network. The committee found that the progress made in wireless during the War had completely changed the outlook. Plant was now available of at least double the effectiveness of the pre-War wireless chain proposals. Accordingly the Norman committee recommended that wireless stations of about 250 kilowatts power, giving 120 kilowatts of continuous wave power to the antenna, should be erected in Egypt, East Africa, South Africa, India, Singapore, Hong Kong and Australia, with, possibly, similar stations in Canada for trans-Atlantic and trans-Pacific communication; and that a station of double the power of the others should be erected in England. Stations such as these, it was thought, would each be able to communicate at all hours with its nearest colleague even under the very bad conditions that afflict wireless reception in the tropics; and each would communicate with its most distant colleague during at least a few hours daily. The scheme ensured that each point would communicate with every other at all times; directly when conditions were good, indirectly—that is, by the relay or passing-on principle as used in cable telegraphy—when conditions were bad. The English station being the most powerful of the network would have the maximum amount of direct communication with all. Besides this, the scheme would enable the Admiralty to transmit instructions from Whitehall to ships afloat anywhere, a requirement included in the terms of reference of the committee.

At this date there were no wireless stations in existence as powerful as those recommended, and, therefore, it was difficult to forecast what their performance would be. Moreover, the committee recommended that the stations should be equipped with thermionic valves. Now the largest valve station then known was of less than 20 kilowatts output, so the recommended English station was to be more than twelve times as powerful as its largest predecessor. The report was, clearly, somewhat ahead of its time, but not, I think, too far ahead. For by the year 1925, only five years later, the Post Office station at Rugby has been built with thermionic valves yielding double the output recommended by the committee. The Rugby station has shown besides, during the tests of the past few months, what the Norman committee's stations could have done. For example, the station recommended for South Africa would have communicated direct with England, Australia and India many hours each day, and the English station would have worked direct to the antipodes more than twelve hours daily.

Lord Milner on receiving the report was, I believe, especially pleased that stations were proposed for some of the dependent Colonies, such as East Africa, Singapore and Hong Kong; not merely because they would serve at times as telegraphic links between England and some of the great Dominions, but as ends in themselves. These intermediate stations would bring great areas of new country into closer touch with all other parts of the Empire. Lord Milner was convinced that the dependent Colonies had for many years past been neglected, and that wireless telegraphy would help to alter this state of things. So at the end of 1920 the Cabinet appointed the Wireless Telegraphy Commission, of which Lord Milner became chairman, and officially assigned to it the task of getting as much done as it possibly could.

As no station could be erected until the requirements of all parties could be co-ordinated, the first task was to obtain unanimous consent to the scheme or a modification of it. It was unfortunate that Lord Milner retired from political life before any decisions were reached by the Dominion Governments. As it turned out, each Dominion Government held a different view about Imperial wireless, partly as to the financing and management of it, partly about the technical requirements and possibilities. The only common element was that they each desired to communicate with England without intermediate steps. Thus as fast as each Dominion settled its policy, a new compromise had to be framed for the Cabinet's approval. Finally, when Mr. Amery was chairman of the Imperial Communications Committee in 1923, Empire wireless took a new spring. The Government decided to erect in England without further delay a wireless station powerful enough to transmit almost continuously to all the Dominions and dependent Colonies, and to all ships of the navy and the mercantile marine wherever they might be.

The time of waiting had not been lost. The Commission had proceeded a long way with the plans of a large station, and the Post Office engineers had gained much experience by equipping with up-to-date plant the medium power stations at Leafield and Abu Zabal, remnants of the old Imperial scheme of 1913. As a consequence the erection of the Rugby station,

the most powerful in the world, has gone forward with exemplary smoothness and without accident or failure of any kind. The Rugby station when in full swing will probably be able to transmit simultaneously three long-distance telegrams and a telephone message. The ultimate aim of the telephone section is to connect any telephone subscriber in Great Britain to any subscriber in the United States and Canada. By aid of the telephone circuits already constructed between England and the Continent, it may be found possible later to connect any one in western Europe to any one in North America through Rugby.

When it is realised that this multiple service station has cost only about half what the single service station near Bordeaux cost in 1919, one appreciates the great strides that wireless design has made during the past few years. Rugby, in fact, has cost about 400,000*l.*, much less than even the new stations at St. Assise near Paris and on Long Island near New York. Further, as the Leafield station began to earn, within a year of its opening, more than covered its working expenses, so we may reasonably look forward to the Rugby station soon becoming a profit-earning concern.

It has always been obvious that the telegraphic traffic to and from the centre of the British Empire will be greater than that to and from any of the Dominions; for the centre has to deal with all the Dominions, all the dependencies and with distant shipping. The spokes all meet at the hub of the wheel. Therefore Britain must make much greater provision than even the largest Dominion, perhaps tenfold. Definite recommendations for the erection in England of stations additional to Rugby were made in the report of the Imperial Wireless Telegraphy Committee, February 1924, presided over by Sir Robert Donald. An opportunity of meeting the recommendations came in the summer of 1924, when the British Government, finding the majority of the Dominions would probably agree to use the Marconi beam system, made a contract with the Marconi Company which will result in the establishment of duplex beam circuits between Canada and England, Australia and England, South Africa and England, and India and England. The arrangement promises a happy solution of many long-standing difficulties. These beam stations are now nearly completed. A transmitting station at Bodmin serves Canada and South Africa, and a station at Grimbsy serves both Australia and India. Corresponding stations are being erected in the four Dominions.

The beam stations may claim to send their messages straight to the desired objective since the guaranteed angle of concentration of the waves is 30°. There is the additional advantage that little power is consumed, partly because of the concentration and partly because short waves are used. This again implies small capital outlay, so at first it was thought that suitable beam stations would be very inexpensive. In practice the engineers met many snags, and it is probable that the English beam stations for communicating with four Dominions will cost altogether about half as much as Rugby. For this expenditure good communication is guaranteed for a daily average of 18 hours with Canada, 7 hours with Australia, 11 hours with South Africa, and 12 hours with India.

It has been suggested that beam stations may some day supersede the wireless stations which send their waves all round. This kind of controversy is always going on in wireless and other progressive sciences, and sometimes tends to cripple action to-day by promising cheaper alternatives to-morrow. As an example, when the motor-car gained its first successes we were told that railways were obsolete; but one can still travel by train from London to Edinburgh more comfortably, more cheaply, and more quickly than by car. As regards the wireless problem, the present beam stations are the first of their kind and have not yet been operated. We only know enough to say that both systems will be useful, and that each can do something the other cannot.

Before the end of this year the long-range wireless transmitting equipment of the British Empire will include—

(1) The multiple station at Rugby, comprising:
  (*a*) Long wave plant of world-wide range.
  (*b*) Long wave plant of medium range.
  (*c*) Short wave plant of world-wide range.
  (*d*) An experimental telephony plant of range 4000 miles.
(2) Medium power stations using long and short waves at Leafield, Oxfordshire, and at Abu Zabal, Egypt.
(3) Four duplex beam circuits for communication between England and the four largest Dominions.

Thus by the efforts of the engineers of the Post Office and the engineers of the Marconi Company, the British Empire will shortly possess the most up-to-date wireless equipment in the world.

So far I have dealt with things nearly completed, but now I must indicate briefly what has yet to be attempted and is within reach. In the first place, there are important communities still unprovided with long-distance wireless; for example, New Zealand. This urgent necessity was emphasised in the report of the Donald committee. In the second place, preparations ought to be made to utilise fully the new facilities. For example, twice a day Rugby transmits a summary of news prepared by the Foreign Office, and conceivably other news services may be arranged. If I were a settler in Uganda or the owner of a remote sheep station in Australia, I should install a simple receiving set and so keep in touch with the world. But this implies learning the morse code, not so hard as learning to use a typewriter, but still a difficulty; and therefore in small communities where there is a local news sheet, it would be more practical to organise a receiving service by paying an operator to listen regularly and decode the messages for the printer. In the British Empire there are innumerable remote settlements to which the cabled news messages leak very slowly, and there are many which depend entirely for their news on the occasional visit of a ship. All such outposts can now, by the aid of a simple receiving set, be made to feel that they are within five minutes of Fleet Street. Moreover, if these stations were registered, messages could be specially addressed to them from England just as telegrams are addressed from Rugby to-day to ships on distant oceans.

Another method of distributing the morse messages from home when received, say in New Zealand, is to

announce them, after decoding, through the local broadcasting stations. In each of the Dominions such stations are growing in numbers, and by their aid messages could be distributed promptly to millions of listeners-in. Of course it may some day be possible, after further invention and development, for speech and music from England or other centres to be put on to every local broadcasting station in the British Empire.

This does not exhaust the possibilities now arising. During the past two or three years wireless amateurs have succeeded in transmitting signals and even speech across vast distances with tiny apparatus. The plant used is so small that it could be installed in a drawing-room. If only we could rely upon plant of this size getting through for days instead of hours, then there would be no need for high-power stations. Even so it is easy to imagine how such glimpses of intercommunication might be made use of in the elaboration of Empire wireless.

The chief results expected from all these efforts to establish an Imperial wireless network can be put in two sentences. Firstly, mutual trade will be facilitated by rapid and cheapened communications, and finance will benefit by a shortening of credit such as followed the introduction of the cables. Secondly, the interchange of opinion between all sections of the British Empire will become fuller; and just as wireless on the small scale has become, in the shape of broadcasting, an important social influence in Great Britain, so wireless on the large scale will have a similar influence in, and strengthen the unity of, the British Empire.

Segregation and Related Problems.

THE laws of evolution and heredity have generally been regarded as universal in their application both to plants and animals. The various theories of evolution have been held by their authors to apply indiscriminately to both kingdoms, and the same has been true of theories of heredity and, with certain limitations, of cellular structure and mitotic division. But there are signs in the more recent developments of genetics that these general resemblances, fundamental as they are, have been over-estimated. In the future, we may expect to see greater emphasis laid on the distinctions, many of which are also fundamental, between animal and plant structure, especially as they affect variations and hereditary behaviour.

The tendency to recognise a divergence between plants and animals in certain aspects of their genetical and evolutionary behaviour has become increasingly evident, both on the breeding and on the cytological side. This tendency is well exemplified in the recent paper on segregation, by Bateson (*Journ. Genetics*, vol. 16, No. 2), the last, unfortunately, which he published before his lamented death. It was the Leidy Memorial Lecture delivered at the University of Pennsylvania in 1922, and in it the greatest biologist, perhaps, of his generation discusses the nature of segregation and the various problems connected with it. In recent years the Merton Laboratory had made extensive studies of variegation in many plants and of various forms of somatic segregation, especially from root cuttings. These in Bateson's hands furnish the basis for a consideration of the nature and significance of the many forms of segregation observed. The fact emerges that not only are most of these forms known only in plants, but also that somatic segregation when it occurs in animals is usually quite different in genetic behaviour and significance.

The term *anisogeny* is introduced for the numerous cases now known in Matthiola, Oenothera, Linum, Campanula, Begonia, and other plants, in which the male and female gametes are carrying separate factors, and it is not clear that this is always due to the loss of one class of gametes after segregation in meiosis. Not only does the place of segregation vary in the many kinds of somatic segregation now known, but also it has been shown by Miss Andersson in the variegated hart's tongue fern that all the 64 spores of any sporangium are alike in the form of plastid they transmit, this depending only in part on the plastid characters of the vegetative tissue from which the sporangium arises. The well-known experiments with rogue peas, made by Bateson and Punnett, Miss Pellew, and others, indicates that here is an orderly type of progressive somatic segregation occurring from below upwards in the plant and accompanied by anisogeny.

Bateson returns to the presence-absence hypothesis and makes out a case for it, based particularly on the interpretation of multiple allelomorphs; for example, the yellow 'eye' series in *Primula sinensis* and the colour series in rabbits. These, as he points out, characteristically form a plus or minus quantitative series as regards one character. The quantitative interpretation of a multiple allelomorphic series is very probably correct; but even so, any advantage of the presence-absence conception appears to be merely a matter of convenience in symbolism. It is, of course, possible that all variations are in essence quantitative. We seem to be arriving at a position in which no essential difference remains between the presence-absence conception and that of each pair of allelomorphs as the result of a germinal change.

In the same number of the *Journal of Genetics*, Castle, Punnett, and Pease continue their discussion of the various types of 'Dutch' rabbits, which have taken the place of the hooded rat as material for the explanation of an apparently continuous series of variations. Castle contends that Self, Dark, and White Dutch form an allelomorphic series, together with modifying factors, while Punnett argues that Dark Dutch is the basic condition, which becomes self-colour through the addition of modifiers. It would follow that an allelomorphic series is not involved in this case; but to settle the matter finally a further study of the linkage relations may be required.

It is clear that segregation remains the central conception in modern genetics, the science which Bateson founded. But it takes a great variety of forms, particularly among plants. Their further elucidation will lead us into new fields.

R. RUGGLES GATES.

New Foreign Members of the Royal Society.

LAST week the Royal Society proceeded to the election of eight foreign members, men of science distinguished in various departments. Their inclusion fills a series of vacancies, occasioned by deaths, which had arisen since 1921.

In the early days of the Society's history, it was the custom, on the election of specially notable philosophical inquirers and workers, not of English birth, to send them an ornate diploma carrying the Society's seal. Birch, the historian, records that, in 1680, "Dr. Gale was called upon for the diploma to be sent to Mr. Leewenhoeck, and it was ordered that the society's seal should be affixed to it, and that a silver box should be provided for it."

Subjoined are the names of the newly elected members with some details of their respective careers.

PROF. MARTINUS WILLEM BEIJERINCK.

Prof. Beijerinck is regarded as the foremost bacterial physiologist of his time. He was the first to isolate in pure culture the bacteroids of the Papilionaceæ and to study filter-passing viruses of plant. He began in 1884 an important series of memoirs, which were published by the Amsterdam Academy of Sciences. They dealt with photogenic bacteria, anaerobes, and kindred subjects. Two of his papers may be cited: (1) "Die Bacterien der Papilionaceen-Knöllehen" (*Botanische Zeitung*, 1888), (2) "Les expériences sur les bactéries lumineuses" (*Journal de Micrographie*, 1891).

PROF. NIELS BOHR.

Born at Copenhagen in 1885, Prof. Bohr received his academic training at the Universities of Copenhagen, Cambridge, and Manchester. At the last named he spent four years working with Sir Ernest Rutherford. Returning to Copenhagen in 1917, he gathered round him a band of helpers in attacking the complex problem of atomic structure from the spectroscopic side. Author of the conception to which the name Bohr-atom has been attached, he has made fundamental advances in interpreting spectroscopic phenomena in terms of quantum dynamics. He was Hughes medallist of the Royal Society in 1921, and received the Nobel Prize for Physics in 1922. Prof. Bohr delivered the seventh Guthrie lecture of the Physical Society, in 1922, on "The Effect of Electric and Magnetic Fields on Spectral Lines."

PROF. ERNST COHEN.

Born at Amsterdam in 1869, Prof. Cohen was formerly occupant of the chair of physical chemistry in the University of that city. He is now professor of physical and general chemistry and director of the Van't Hoff Laboratory in the University of Utrecht. He has published many chemical memoirs through the Amsterdam Academy of Sciences and in the *Zeitschrift für physikalische Chemie*. He is distinguished for his researches on the allotropic states of the chemical elements. As a pupil and follower of Van't Hoff, chemists owe much to him for methods by which sound foundations have been laid for physico-chemical theory. Prof. Cohen recently was elected president of the International Union of Pure and Applied Chemistry.

PROF. WILLEM EINTHOVEN.

Born at Semarang, Java, on May 21, 1860, and educated at Utrecht, Prof. Einthoven has been, since 1886, professor of physiology in the University of Leyden. Early in his career he was an assistant of Donders. He is LL.D., Aberdeen, and in 1924 was the recipient of the Nobel prize for medicine. Prof. Einthoven has devised instruments specially adapted to the study of physiology, as well as those suitable in high degree for physical researches. Important papers have illustrated and illuminated his procedure. One memoir of his may be cited, namely, "On the Theory of Lippmann's Capillary Electrometer" (1900).

PROF. KARL E. RITTER VON GOEBEL.

Born at Billigheim, Baden, in 1855, von Goebel was educated at the Universities of Tübingen, Würzburg, and Strasbourg. He is a foreign member of the Linnean Society. Elected to the chair of botany at Strasbourg in 1881, he later occupied posts at Rostock and Marburg, down to the time when he became professor of botany at the University and director of the Royal Botanic Gardens, Munich. An authority on the mosses and liverworts (Bryophyta), some of his work has appeared in English under the title "The Organography of Plants" (Oxford, 1905). He is an honorary LL.D. of the University of St. Andrews.

PROF. HENRY FAIRFIELD OSBORN.

Born at Fairfield, Connecticut, in 1857, Prof. Osborn graduated at Princeton University, U.S.A., holding there (1880–91) the assistant professorship of comparative anatomy. Afterwards (1891–1910) he occupied the chair of zoology in Columbia University, New York, and is now research professor of zoology there. Prof. Osborn is among the most distinguished palæontologists of our time. His first publication (1883) dealt with the structure of the brain in amphibia; later memoirs dealt mostly with fossil vertebrates. One of the results of his work is the more precise determination of the relative ages of the extinct mammals of North America. As director of the American Museum of Natural History, Prof. Osborn has made the institution world-famous. He has had distinctive influence in establishing a school of younger palæontologists. In 1918 he was Darwin medallist of the Royal Society. In our recent special issue relating to the centenary of Huxley (May 9, 1925), Prof. Osborn contributed an interesting article entitled "Enduring Recollections."

PROF. MAX PLANCK.

Prof. Max Planck was born at Kiel in 1858. Formerly a professor in the University of Kiel, he is now professor of mathematical physics and director of the Institute of Theoretical Physics in the University of Berlin. His outstanding achievement has been the foundation of the quantum theory—Planck's constant is now considered to be one of the fundamental constants in Nature. Planck first discovered the true law of black body radiation; then showed how this could be satisfactorily explained in terms of a system

of dynamics. From this the modern quantum theory has grown, with all its far-reaching developments.

PROF. ARNOLD SOMMERFELD.

Prof. Sommerfeld was born at Königsberg in 1868, and was educated there and at Göttingen. Formerly holding professorships at Claustal and Aachen, he is now professor of theoretical physics in the University of Munich. His book "Atomic Structure and Spectral Lines" (English edition) contains an account of mathematical work on the structure of the atom, his own contributions being of very high value.

Obituary.

ADMIRAL SIR JOHN FRANKLIN PARRY, K.C.B.

ADMIRAL SIR JOHN FRANKLIN PARRY, K.C.B., whose death occurred at Harrogate on Wednesday April 21, had a long and distinguished record in H.M. Navy, principally as a hydrographic surveyor and as Hydrographer of the Navy.

Born on August 15, 1863, Parry joined the Royal Navy in 1877, being promoted to lieutenant in 1885, commander in 1899, captain in 1905, and rear-admiral in 1916. He first joined H.M. Surveying Service in April 1884, being appointed to H.M.S. *Triton*, surveying on the east coast of England. After a short period in that ship he was appointed to H.M.S. *Rambler*, where he served from November 1884 until March 1889 in the Red Sea and Far East, receiving the Egyptian Medal and Khedive's Bronze Star for the part he took in the naval and military operations at Suakin in 1884–1885. In 1888 he was landed in command of a party at Mempakol, British North Borneo, to protect the Resident Commissioner from an attack by hostile natives. His next ships, all employed on hydrographical surveying, were the *Penguin*, *Triton*, and *Dart*, and whilst in the latter as senior executive officer he succeeded to the command of her, after two years' service, in 1897. He remained in command carrying out important surveying work in Australian waters until the middle of 1900.

From August 1900 until February 1903 Parry held the important post of Chief Civil Assistant to the Hydrographer (Admiral Sir William Wharton, K.C.B., F.R.S.), and from that post assumed command of H.M. Surveying Ship *Egeria* surveying in British Columbia, where he remained until 1906. He was then appointed in command of H.M. Surveying Ship *Merlin* surveying in the Red Sea and north-west coast of Borneo, but only remained until the end of that year, being incapacitated through sickness. He was appointed to H.M. Surveying Ship *Egeria* again in 1908, remaining with her surveying in British Columbia until April 1910, when he completed his hydrographic work afloat.

As Assistant Hydrographer from April 1910 until August 1914, Captain Parry carried out much important work in connexion with hydrography and allied subjects. Amongst other positions he represented the Admiralty on the Board of Trade Committee on Derelicts in 1912, and on the conference on the subject of the Atlantic ice patrol following the loss of the *Titanic*. He was also British delegate to the French conference on the use of wireless telegraphy in connexion with time and weather, and served as chairman of the important Admiralty Committee on the re-organisation of British Admiralty charts.

Appointed Hydrographer of the Navy on September 1, 1914, Captain Parry held this post throughout the War and until August 31, 1919. During this period the work of his Department was very largely increased to meet war requirements, and although the surveying ships employed were necessarily reduced to a minimum, the surveyors' activities afloat, and in connexion with the Hydrographer, were very much increased, and under his direction the numerous and varied calls for new forms of charts and other technical hydrographic publications were fully met. His last important work, before retiring as Rear-Admiral and from being Hydrographer, was to preside over the International Hydrographic Conference in London in June 1919, when forty-five delegates, representing twenty-five nations, met to discuss the standardisation of hydrographic charts and publications, and kindred subjects.

After retirement as Hydrographer, Sir John Parry was employed as a member of the International Hydrographic Bureau Committee until June 1921, when the Committee was dissolved; then becoming, by election, senior director of the International Hydrographic Bureau, Monaco, which post he held to the day of his death. During 1920 he was also employed by the contractors for the Crown Agents for the Colonies in making an examination of a suitable locality on the Gold Coast to determine the best site for a deep sea harbour. Sir John Parry undertook the sole charge of this expedition, and the valuable work therefrom resulted in Takoradi Bay being chosen, where the building of the new port is now well advanced.

In recognition of his services Parry was made C.B. in 1916 and K.C.B. in 1919. He also received the Cross of Commander of the Legion of Honour (France) and the Distinguished Service Medal (U.S.A.). He was a fellow of the Royal Geographical Society, being elected in 1917. He was promoted to Vice-Admiral on the Retired List on November 25, 1920, and to Admiral on November 24, 1925.

MR. F. C. L. WRATTEN.

IT is with much regret that we learn from the *British Journal of Photography* of April 16 of the death of Mr. F. C. L. Wratten at the age of eighty-six years. Mr. Wratten came from Hellingly, Sussex, when he was twenty-one, and became a clerk in the photographic firm of Solomon's of Red Lion Square. In 1877 he entered into partnership with Henry Wainwright (who died in 1882) and established the well-known firm of Wratten and Wainwright in Great Queen Street, London.

As soon as gelatine was shown to be a possible medium for photographic plates and to offer advantages that collodion does not possess, Mr. Wratten took up the matter, and as a result of his experimental investigations was one of the very first (1877) to put gelatino-

bromide dry plates upon the market. These "London" plates were remarkable for their fine quality although made entirely by hand.

Mr. Wratten was also a pioneer in 'instantaneous' photography by taking advantage of the superior sensitiveness of gelatine over collodion plates. In 1882 he photographed the University boat race, and he was the first to photograph the Derby. As soon as gelatine plates became fairly well established, Mr. Wratten started a plate factory at Croydon, and he lived there for the last forty-six years of his life. In 1896 the shop and premises in Great Queen Street were closed. In 1906 Dr. Kenneth Mees joined the firm, and in 1912 the Kodak Company bought the business. Dr. Mees went to Rochester, New York, to establish and conduct the research laboratories there, and Mr. Wratten's son, Mr. S. H. Wratten, became the head of a technical department of the Kodak Company.

News and Views.

ON March 9 Dr. Arthur Wade read a paper before the Institution of Petroleum Technologists in which he embodied the results of his experience of oil exploration in Australia and Papua. As he pointed out, in no part of the world have the Government and people of a country been more anxious to obtain indigenous supplies of petroleum than in Australia, but so far this natural desire has not been realised. Many geologists have concluded, and with good reason, that owing to the fundamental character of the Australian continent, and its similarity to the great Archæan shields of the earth's surface, it lacks either the marine sedimentary cycles or the tectonics with which one associates the main oilfields of the world; hence the chances of locating large oil-pools are remote. The author felt that this was a dangerous generalisation for a continent, though he admitted that very large areas in Australia were distinctly unfavourable to the occurrence of oil; he stated "the close study of a few areas of comparatively limited extent leads one to the conclusion that commercial pools of oil do occur elsewhere in association with conditions . . . (characterised by) . . . the presence of abnormal factors which operate locally and are not usually active in productive oilfield areas."

DR. WADE dealt with the various direct and indirect indications of oil in the continent of Australia, but it cannot be said that in any one instance these amount to much: South and Western Australia have nothing to offer which can be construed as being in the slightest degree favourable. Of the Northern Territory he says: "Copper, gold and tin are more certain of providing the prospector with adequate returns for his work than is petroleum." The possibilities of Queensland seem to be based on the historic find of natural gas in a water-well at Roma in 1897; but subsequent drilling has not proved successful. In New South Wales an application of the American 'carbon-ratio' hypothesis has directed attention to the Sydney coal basin; but the author himself dispelled optimism in prospects here by his careful scrutiny of the data, though he considers the chances of locating natural gas favourable. In other parts of the continent very little is known of the geological conditions, save in broadest outline, though there is apparently little to commend them as potential oil-producing areas. With regard to Papua, geological circumstances are entirely different from those of the Australian continent, and chances of locating commercial pools are much more favourable; conditions of exploration and operation are extremely difficult in this territory, but past developments have not been without some success, and now that the Government has recently abandoned its monopoly to drill, private enterprise may well be productive of satisfactory results in the course of time.

SIR JOSEPH THOMSON gave the Kelvin Lecture to the Institution of Electrical Engineers on April 22. He chose as his subject the mechanics of the electric field, a subject, he said, which was never long absent from Kelvin's thoughts. He pointed out that the ordinary laws of electro-magnetism and of the dynamics of the electric field merely represent the relations between averages taken over a time which, though small, is finite and comparable with the times that occur in the atom. These relations, however, are meaningless when times less than the times for which the averages have been taken are considered. When considering the orbits of electrons, the principle of the conservation of energy holds only when taken on the average. When electric waves are generated by an electron in an atom, the time constant of the force increases as the force becomes weaker. When the field is very intense, the time constant is very small and the ordinary equations hold. When electric radiation becomes weaker and weaker, a place is reached where the time constant is comparable with the period of vibration; when this occurs the radiation is reflected. It will not go out into space. The waves coming back to the electron will restore the energy to it which they originally received. This can be applied also to an electron revolving in an orbit and leads to a corpuscular theory of light. In this theory, light is regarded as travelling out in bundles, the energy in each bundle diminishing as it goes through space. Sir Joseph is of opinion that the isolated positive hydrogen atom may be capable of producing vibrations which are very short even when compared with the vibrations of Röntgen rays.

THE Perthshire Natural History Museum, which ranks high amongst local institutions of its kind, has been busy setting its house in order as regards its collection of Mollusca. Mr. Henry Coates has been occupied for some years past in amalgamating the interesting and important collections presented at different times by various donors, in arranging them for exhibition, and in preparing a catalogue, which is now published in the *Transactions of the Perthshire Society of Natural Science* (vol. 8). Mr. Coates has prefixed a brief history of the collection, the extent of

which may be gauged by the fact that the catalogue occupies some 75 pages in 8vo. In common with all curators he complains of the great difficulties encountered in the matter of classification and nomenclature, and bewails the lack of a thoroughly comprehensive book giving a complete survey of the Mollusca, which, as he remarks, has still to be written. Among the old and new authorities cited as consulted we should have thought that Pelseneer's volume in the Oxford "Treatise on Zoology" and Fischer's "Manuel" ought to have found place. Illustrations of the exhibition cases, explaining the structure and development of the Mollusca, are given and show how admirably this feature has been carried out. The legends to the plates, however, are not quite correct. It might have been expected that the home industry carried on at their very doors would have received special treatment; but though illustrations of the old and present methods of fishing for the pearl mussel in the Tay are given, no exhibit of the growth and development of the mollusc is mentioned, an omission which certainly should receive prompt attention, since, as Dr. Boycott pointed out in these columns (NATURE, vol. 114, 1924, p. 276), there is a gap in our knowledge thereof which requires filling, and, if anywhere, it could be made good at Perth.

THE fourteenth International Geological Congress will assemble at Madrid on May 24-31. The principal subjects to be discussed are: (1) phosphates and pyrites, (2) geology of the Mediterranean, (3) Cambrian and Silurian fauna, (4) geology of Africa and its relation to that of Europe, (5) Tertiary vertebrates, (6) Tertiary Foraminifera, (7) Hercynian folds, (8) metallogeny, (9) vulcanism. There will be excursions before the meeting to the Straits of Gibraltar, the Mountains of Ronda, Linares and Huelva, the Guadalquivir, the Sierra Morena and Sierra Nevada, Burgos, the Canaries; during the meeting, to Almaden, the Guadarrama Mountains, Aranjuez; and after the meeting to the collieries of Asturias, the iron deposits of Bilbao, Catalonia and the Central Pyrenees, Catalonia and the Eastern Pyrenees, and the Balearic Islands. Any one desiring to take part in the Congress must apply to the Secretary of the Executive Committee of the Fourteenth International Geological Congress, Escuela de Minas, Calle de Rios Rosas, 5, Madrid, Spain, and enclose a remittance of 30 pesetas. A deposit is also required from those taking part in any of the excursions. Arrangements have been made for reduced railway fares to and from Madrid for members of the Congress on the Spanish railways, on the production of a special certificate issued by the Congress.

THE issue of the *Journal of the Royal Society of Arts* for April 2 contains a paper on domestic heating by Dr. Margaret Fishenden, of the Fuel Division of the Research Department, in which the relative costs of different systems of heating are compared. Taking good household coal at 50*s.* a ton, coke at 40*s.*, coal-gas at 10*d.*; a therm, and electricity at 2*d.* a unit, the prices of a therm are, for coal, 1·9*d.*; coke, 1·7*d.*; gas, 10*d.* and electricity 59*d.* For central heating, coal and coke appliances have an efficiency of 50 per cent., while gas and electricity appliances have 100 per cent. The costs of the same amount of heat effect are therefore in the ratios 1 : 0·9 : 2·6 : 15·5, and coke is the most economical. For heating by radiation from a body at high temperature, open fires have an efficiency of about 25 per cent., gas fires about 50 per cent., and electrical radiators nearly 100 per cent. The relative costs of equal heat productions in a room are coal, 1*d.*; coke, about 0·75*d.*; gas, 2*d.*; and electricity, 7*d.* Labour-saving, cleanliness, intermittent use and comfort have to be considered in addition to cost, and in the discussion it was stated that for one person using fires intermittently, gas is as cheap as coal.

SOUTHPORT meteorological observations for the year 1924 have recently been published by the Southport Corporation and the Meteorological Office, Air Ministry, the Fernley Observatory being now auxiliary to the Meteorological Office. Observations at Southport have been continuous for more than fifty years, so that the averages of temperature and rainfall are excellent for a health resort, and the observer, Mr. Joseph Baxendell, who is meteorologist to the Corporation, ranks amongst the foremost observers in meteorology, and commonly introduces material of much value into his annual report. The outstanding feature of 1924 is said to be a record frequency of southerly winds, and in consequence the year was very dull, decidedly wet, and fairly warm. The only months noteworthy for trying 'cold' winds were February and March. Due northerly winds were of less than normal frequency in every month except February. December was one of the mildest ever experienced. Though 1924 was wet it was less so than in many districts; there have been quite a number of wetter years and several more dull since observations were established in 1871; five of the twelve months were drier than usual, the run of rainy weather from July to October being very unfortunate. Only three months were brighter than is customary, almost the whole of the year's large shortage of sunshine occurring during the summer half year. In the appendix to the report for 1924 the periodicity for a small number of years is given from the harmonic analysis of 53 years' records of Southport rainfall. This is rather bold for a health resort. July and September of 1926 are both approximate dates of maxima rainfall, the earlier of periodicity 2·85 years, the later 2·19 years; the value of the forecast can soon be proved.

AT a meeting of the Illuminating Engineering Society on April 29 a paper on "School Lighting (Modern Requirements and Recent Progress)" was read by Dr. James Kerr, who is chairman of the Joint Committee formed by the Society to inquire into this subject. Since the reports issued by this Committee in 1913, substantial progress in illuminants and lighting appliances has been made. The importance of adequate access of daylight has been emphasised by the recent recognition of the part played by ultraviolet radiation in sunlight in relation

to health. For artificial lighting the Committee originally recommended a minimum of 2 foot-candles. Dr. Kerr suggested that in view of recent progress a value of 5-7 foot-candles should now be aimed at. He also emphasised the desirability of extra lighting of the blackboard, and proposed a general recommendation that sources within the direct range of vision should be toned down to 3 candles per sq. in. Dr. Kerr mentioned favourable experience with a local lamp equipped with daylight-glass so as to remove excess of red-yellow light, and he suggested that the use of suitable light-filters in schools for myopic children deserved investigation. Dr. E. H. Nash (Medical Officers of Schools Association) presided. Various representatives of educational bodies took part in the discussion, in which the importance of adequate lighting, both natural and artificial, in schools was strongly emphasised.

A LECTURE given by Mr. C. E. R. Sherrington on "Rail Transport Systems of the United States" has been published in the March number of the *Journal of the Institute of Transport*. The lecture is a useful one, as it emphasises the great difference there is between rail transport in Britain and in America. With the exception of rubber and coffee the United States is practically self-supporting. Its trade is therefore mainly internal. But in order to benefit by large-scale production in steel and similar industries where overhead charges form a large fraction of the total, the surplus is exported abroad. This has the effect of cheapening transportation and tends to concentrate large-scale industries. The opening of the Panama Canal and the agricultural depression had serious effects on the Chicago to Pacific coast lines. The Chicago, Milwaukee and St. Paul Railway was forced into receivership. This was unfortunate, as this road had electrified 648 miles of its main line through the Rockies down to the Pacific coast in 1920, and to opponents of electric traction the effect produced seems to be due to this cause. In reality the traffic through the north-western States did not warrant the building of three trans-Rocky mountain lines. Electrical engineers are studying closely the working of the new Diesel electric engines. If these prove satisfactory they will serve as a deterrent to further electrification.

THE report for 1925 of the Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington records a fruitful year's work. The Department has co-operated with other American research institutions in the investigation of the conducting layer in the upper atmosphere by means of reflection of wireless waves, and the results obtained seem to be in accord with those obtained in Great Britain by Appleton and Barnett, and Smith-Rose and Barfield. In co-operation with the Carnegie Institution Geophysical Laboratory, work is being done on the effect of pressure on the critical temperature of magnetisation; the results to date are confined to nickel, using pressures up to about 2000 atmospheres, but the effects seem to be very small: the research is of interest in connexion with the depth to which permanent magnetisation of ferrous rocks in the earth's crust can exist. The reduction of the observations of atmospheric potential gradient, made on the various cruises of the *Carnegie*, has made it possible to attempt, for the first time, the construction of isoelectric charts for the greater part of the earth's surface—the oceans. Several questions of purely atomic physics, not at present obviously related to geophysics, have also been investigated under the auspices of the Department. Much observational work in terrestrial magnetism and electricity has also been accomplished, particularly at the two observatories of the Department—at Watheroo, Western Australia, and Huancayo, Peru.

THE Report of the Marlborough College Natural History Society contains its usual lists of observations in natural history, meteorology, etc. A list of about 113 fungi of the district is given by C. P. Hurst and twelve flowering plants are added to the hand-list. The permanent record of the risings of the Rockley Bourn with a graph of the last twenty-four years is due to L. G. Peirson; it is a 'winterbourn' or 'hungerbourn,' a stream appearing in normally dry valleys in chalk country. Brentnall's account of the local Manor of Rockley is charming and quite suitable. A quite important and well illustrated paper on Cyclops, by A. G. Lowndes, records seventeen of the thirty British species in correlation with the *p*H value of the water in which they lived, and describes three forms; such systematic research should be published in a regular biological journal, or it will be missed by most workers.

DR. A. DAUVILLIER, of Paris, is to deliver the seventh Mackenzie Davidson Memorial Lecture before the Röntgen Society and the Electro-Therapeutics Section of the Royal Society of Medicine on May 20 at 8.15 P.M., taking as his subject "The Measurement of X-ray Dosage." The lecture will be delivered at the Royal Society of Medicine.

AT the annual meeting of the members of the Royal Institution, held on Saturday (May 1), the following officers were elected: *President*, The Duke of Northumberland; *Treasurer*, Sir Arthur Keith; *Secretary*, Sir Robert Robertson.

THE International Association for Psychology and Techno-Psychology (*i.e.* Industrial Psychology) began its official activity on March 15. Fifteen European countries are represented in the Association, the administrative headquarters of which are at Riga, under the direction of Dr. Moeller. In England the Association is represented by Prof. T. H. Pear, University of Manchester, and its department of Techno-Psychology by Dr. C. S. Myers, National Institute of Industrial Psychology. The first publication of the Association will be "A Survey of the Organisation and Position of Techno-Psychology."

WE regret that by a slip in our note on the explorations in Derbyshire caves (NATURE, April 24, p. 598), the name of the archæologist by whom the investigations are being carried out, was wrongly given. The work is in charge of Mr. A. Leslie Armstrong.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A professor of pure mathematics and a professor of chemistry in the Egyptian University, Cairo—The Director, Egyptian Education Office, 39 Victoria Street, S.W.1 (May 14). A public analyst for the Metropolitan Borough of Bethnal Green—The Town Clerk, Town Hall, Bethnal Green, E.2 (May 17). A head of the department of mechanical engineering and a lecturer in the department of civil engineering, architecture and building in Bradford Technical College—The Principal of the College (May 19). Junior assistants at the National Physical Laboratory with good honours degree and, if possible, research or technical experience in one of the following subjects: physics, electricity, metallurgy, engineering, aeronautics, naval architecture—The Director, National Physical Laboratory, Teddington (May 22). A professor of physics at the School of Engineering, Giza, Cairo—The Minister of Education, Cairo (May 30). An analyst in connexion with the Dairy Produce Act, 1924, in the Department of Agriculture, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (May 31). A bacteriologist in connexion with the Dairy Produce Act, 1924, in the Department of Agriculture, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (June 30). A director and an assistant director of the Research Association of British Paint, Colour and Varnish Manufacturers—Mr. J. B. Graham, 8 St. Martin's Place, W.C.2. A lecturer in geography and nature study at the Bedford Training College—The Principal. A resident tutor in geography at the Borough Road Training College, Isleworth—The Principal. A head of the chemistry department of the Huddersfield Technical College—The Director of Education, Education Offices, Huddersfield. A principal of the Derby Technical College—The Secretary, Education Committee, Becket Street, Derby.

Our Astronomical Column.

INVESTIGATION OF TRANSITS OF MERCURY.—Prof. Newcomb was the first to suggest that the unexplained fluctuations of the moon might really be fluctuations in the earth's rate of rotation. The suggestion can be tested by studying other heavenly bodies with rapid motion, notably Mercury and the inner satellites of Jupiter. Newcomb himself discussed transits of Mercury up to 1891, but failed to obtain definite confirmation of variation in the earth's rotation. *Union Observatory Circular* No. 65 contains a new investigation by R. T. A. Innes; he has repeated Newcomb's work, correcting a few minor errors, and has included the four recent transits of 1894, 1907, 1914, 1924, all well observed. The semi-diameters deduced for the sun and Mercury at unit distance are 959″·48 (0″·15 less than that of Auwers) and 3″·08. The latter is undoubtedly less than the real semi-diameter of Mercury, owing to irradiation.

A diagram is given of the time-residuals of the transits from 1677 to 1924; they are compared with Newcomb's diagram for the moon, and there is a certain similarity between them. Both have maxima near 1680 and 1885, and a minimum about 1780; the curve for Mercury between these limits is much more undulating than the lunar one. Jupiter's satellites I, II, are also used for the last thirteen years, and accord well with the Mercury curve in showing a rapid downward movement.

There is therefore a fair case for ascribing the errors in position of the different bodies to a common cause, namely, changes in the earth's speed of rotation. Dr. Innes seems to be in error in one point. He mentions the error of the equinox as due to a similar cause. But a shift of the sun along the ecliptic does not affect the position of the intersection of ecliptic and equator.

MASSES OF STARS OF TYPES F TO K.—*Astr. Nach.* No. 5434 contains an article on this subject by B. P. Gerasimovic. He points out how few stellar masses are accurately known, and how useful it would be to find a general method of obtaining them in the case of stars without visible companions. Two methods have been suggested; first, that of the equipartition of energy, which if established would correlate mass with velocity; secondly, Pannekoek's method from comparison of trigonometrical parallaxes with spectroscopic ones. The latter method is complicated by the effect of radiation pressure in diminishing gravitation, especially in the hottest stars.

The author bases his work on the Victoria parallaxes, and the masses of binaries with well-developed orbits. The equipartition principle is first tested; the quantity (mass) × (velocity)^2 is formed for a large number of stars of types F, G, K. The mean values of the product for the three types are 3·47, 3·45, 3·59, in good agreement with Seares's value 3·57 obtained in quite a different manner. It is concluded that both the equipartition theory and Pannekoek's principle are sound, and can be applied statistically, though there may be large deviations for individual stars.

Prof. Eddington's proposition of correlation of mass with absolute magnitude is then tested, graphs being drawn for the different types. They show large departures from linearity, there being evidence of discontinuity between $M = 2{\cdot}0$ and $M = 3{\cdot}5$, about the region of demarcation between giants and dwarfs.

The paper concludes with a list of deduced masses and densities of 74 stars with parallax 0·07″ or greater. The five largest masses are 61 Ursae Maj. 4·1, δ Eridani 3·7, 61^2 Cygni 3·5, η and γ Cephei each 3·0. 61^2 Cygni is given the great density 31·8; that of Arcturus is only 0·0005, its mass being 1·6. These data are only provisional, but they give hope of future increase of knowledge in this very important but difficult field.

Research Items.

CAPSIAN AFFINITIES OF THE LATER STONE AGE CULTURE OF SOUTH AFRICA.—The possibility of connexion between the Stone Age cultures of North and South Africa was discussed with some precision by Mr. A. J. H. Goodwin of the Cape University, in a paper presented to the South African Association for the Advancement of Science in 1925 and now published in vol. 22 of the *South African Journal of Science*. Of the three industries forming the later Stone Age in South Africa, one is the pygmy industry, a second has been named the Smithfield industry. The characteristics of the pygmy culture are scrapers, points, the geometrical pygmy implements, ostrich shell beads, bone implements, paintings on walls or stones, possibly stone palettes, and the habit of eating snails. The Smithfield industry includes duckbill scrapers, of a type larger than the pygmy, and shading to the circular scraper, blades and tanged points. In North Africa in the late Capsian is found a culture with end-scrapers, blades, points, tanged arrow-heads, crescents, ostrich egg-shell beads, and bone awls exactly similar to those of the pygmy and Smithfield cultures of South Africa. There is also the possibility that the North African Capsian may be connected with paintings. It is concluded, therefore, that the later Stone Age of South Africa is an offshoot from the Capsian culture.

MENDELIAN HEREDITY AND RACIAL DIFFERENCES.—Prof. R. Ruggles Gates points out in a communication appearing in vol. 55, Pt. 2, of the *Journal of the Royal Anthropological Institute*, that although innumerable peculiarities and abnormalities are found to be inherited in man as simple Mendelian differences dominant or recessive to the normal or sex-linked in various ways, anthropologists have not yet generally recognised the wide spread of Mendelian inheritance in man. Data relating to such characters as eye colour, stature, and cephalic index, however, are rapidly accumulating. The known facts do not justify the distinction sometimes made that Mendelian inheritance applies only to abnormalities, and that racial differences follow other rules and do not segregate. Eye colour was the first character in man to be recognised as Mendelian in its inheritance. It is well known that it segregates in families. Segregation also occurs in inter-racial crosses. There is nothing at present to indicate that its inheritance in such crosses differs from that within a single race. As regards stature, while it is characteristic in many races, it is clearly not a unitary thing but the result of many diverse elements acting under a particular set of environmental conditions. In the case of the cephalic index it is clear that brachycephaly and dolichocephaly are not determined by a simple Mendelian pair of factors. The work of Fritz, Hildén, and others indicates that the cephalic index may be determined by several cumulative polymeric factors, *i.e.* genetic factors, each of which produces a certain transition from dolichocephaly towards brachycephaly. It appears that such "racial" characters as stature and cephalic index do not differ in their hereditary behaviour from size and shape differences generally, and have no special virtues as being "racial" distinctions. But there is great and urgent need for accurate observations on the results of inter-racial crosses in mankind.

EFFECTS OF THYROID ADMINISTRATION.—Prof. Ercole Giacomini gives an account in the *Rendiconto della R. Accademia delle Scienze dell' Istituto di Bologna* of the interesting results observed on the administration to fowls of thyroid, which produces marked changes in their metabolism and influences more particularly the development, appearance, and colour of the plumage. Ingestion of fresh ox thyroid by young or old fowls of either sex infallibly determines a pronounced stimulus to the production of feathers. In some cases the old feathers are made to fall in a manner so rapidly that in a few days the body may become almost bare, being covered only by the germs of the new feathers, which are surrounded by horny sheaths and resemble short prickles. Moreover, with birds having coloured feathers there takes place an alteration in colour, usually a depigmentation, the extent and intensity of which are enhanced if administration of the thyroid is continued. In certain instances, however, but never with white fowls, the opposite phenomenon occurs, increased formation of black pigment being observed in the feathers on some parts of the body. Similar but less pronounced changes follow the use of dried thyroid.

GENETICS OF LOCUSTS.—Continuing his genetic experiments with grasshoppers, Nabours (*Kansas Agric. Sta.* Bull. 17) has published the data from twelve years' breeding of the grouse locust, *Apotettix eurycephalus*. Eleven different colour patterns of this locust, all found wild, have been bred with the 'normal,' to which they are all more or less dominant, and with each other. More than 134,000 individuals were examined in the experiments, and the patterns of a large number of specimens are permanently preserved in alcohol. By means of the crossing-over data and other hereditary behaviour, all these factors are mapped as belonging in a single linkage group (or chromosome), and nine of them form three groups of multiple allelomorphs containing respectively three, four and two factors. With certain factors, the percentages of coupling and repulsion obtained were quite different. These and certain other inconsistencies are attributed to the highly variable conditions under which the experiments were conducted. Very interesting phenomena of parthenogenesis were obtained in some of the females.

AGE AND GROWTH OF HADDOCK AND WHITING IN ICELANDIC WATERS.—Bjarne Saemundsson writing in *Meddelelser fra Kommissionen for Havundersøgelser, Serie : Fiskeri*, Bind viii, Nr. 1, 1925, states that the haddock has long been one of the favourite food-fishes of the Icelanders. It has also been cured (split and salted) on a large scale for export, being formerly second only in importance to the cod, although it now occupies third place as an article of export, having given place to the herring. From his study of the scales, Saemundsson concludes that the growth of the Icelandic haddock follows a similar rule to that of the cod: "It is most rapid on the south and the west coast, and gradually decreases as we turn to the right round the country, being slowest on the east coast." This decline in growth is attributed to the fall of temperature in the said direction, an influence which also prevents the spawning of cod, haddock, and many other fishes. In comparison with other regions, the rate of growth of the Icelandic haddock is only surpassed by that of the Faeroese; while the size attained is also very large compared with that in more southern waters, so that ages 9-14 years commonly occur. As with the cod, there is a noticeable difference in the size of the sexes, the males being the inferior in size for corresponding age. Sexual maturity is first reached when the fish (both sexes) is four years old and about 47 cm. long. It is significant that the majority of

haddock caught in Icelandic waters, particularly in shallow inshore areas, are young immature fish, but the 5-yearly means of the catches from 1897 to 1919 do not indicate that there has been any decrease in stock as the result. Unlike the haddock, the whiting gives rise to no special or important fishery. This fish is also able to grow to a much larger size in Icelandic waters than in neighbouring seas, and, as with the cod, the female is larger than the male, and probably reaches a higher age. A common feature of the scales of whiting is the presence of a considerable number of narrow rings within the first summer-zone. These narrow rings are only separated from the centre by two or three broad summer-rings, and although they assume the appearance of a normal winter-zone, their position seems to render this interpretation untenable. Saemundsson suggests that this false ring may be looked upon as a consequence of some change in the life of the fish, *e.g.* moving from shallow to deeper (cooler) water, or the transition from pelagic to bottom life.

CHROMOSOMES OF HYACINTH.—The chromosomes of the hyacinth and two related genera have been studied by Mr. C. D. Darlington (*Journ. Genetics*, vol. 16, No. 2), *Hyacinthus orientalis* and *Scilla nutans* having 8 chromosomes, while *Bellevallia romana* has 4. But Hyacinthus is not strictly tetraploid, because one of the four long chromosomes has a constriction which is not found in the other three chromosomes. In Scilla the chromosome sizes and constrictions are different from those of the hyacinth, and neither condition is directly derivable from the diploid Bellevallia, owing to differences in the constrictions and sizes of the chromosomes. It is concluded that the constriction is not necessarily at the point of application of the force which moves the chromosome, and that the centre of attraction of the chromosome is not strictly localised. The latter conclusion is contrary to some previous evidence.

NEW TECHNIQUE WITH FOSSIL PLANTS.—Mr. T. M. Harris describes in the *New Phytologist* (vol. 25, No. 1, 1926) a new method for examining plant remains in shale, by which the whole of the more resistant plant material is rendered available, and not merely plant impressions exposed on split surfaces. The shale is first immersed for some days in strong nitric acid containing about 5 per cent. potassium chlorate; after washing in running water it is then placed in dilute sodium hydroxide, in which it breaks down into a fine mud from which resistant fragments of cuticle, and sometimes of other tissues, can be strained off by wire gauze. These fragments are finally cleaned in 25 per cent. hydrofluoric acid. A great number of leaf fragments, small seeds, bird scales, etc., were thus obtained, together with two characteristic megaspores of *Lycostrobus Scotti* Nath., of which only one other specimen is known. From a piece of shale consisting mainly of *Sagenopteris Nilssoniana* (Brongn.) Ward., pollen grains, anthers, and seeds were obtained which were scarcely distinguishable from those described by Dr. H. Hamshaw Thomas for the Caytoniales. As these organs were not found in other shales, this strengthens the evidence for Dr. Thomas' view that the leaves of the Caytoniales were of the Sagenopteris type. By this method Mr. Harris has been able to study about one-half of the total number of species (106) now known of the early Mesozoic flora from the Rhaetic bed of East Greenland.

DETERMINATION OF THE SALINITY OF SEA WATER.—Prof. Giral discusses in "Quelques Observations sur l'emploi de l'eau normale en Oceanographie" (*Publication de Circonstance No. 90*, International Council for the Exploration of the Sea, Copenhagen) the source of error in calculating the total salts content or salinity of sea water from the chloride content as determined by titration. Although the salts occurring in sea water are present in almost the same proportions in the open oceans, slight variations are known to occur which renders the calculation 'conventional.' The various errors occurring in the usual titrimetric determination of salinity are considered, from which Prof. Giral concludes that these prevent an approximation closer than the first decimal place per kilogram of sea water in all determinations of chlorides and salinity.

LONG-RANGE FORECASTING.—Sir Gilbert Walker gives a summary in the *Meteorological Magazine* for March of some recent papers by W. Wiese. It is mentioned that there has of late been considerable meteorological activity in Russia, and amongst this is the work of Wiese upon conditions in the North Atlantic considered in the light that it may throw on English weather. Associated with years of much ice in the Barents Sea, there is in advance a south-eastward displacement of the axis of the trough of low pressure off the west coast of Norway. An attempt is made to associate ice in the polar seas and the general circulation of the atmosphere extending the connexion between the Arctic and Antarctic, but it is pointed out that this appears to be unproven. There seems to be a close relationship between Barents ice and air temperature in Europe. The influence of the mean air temperature in spring in N. Iceland on the mean air temperature of the following winter in Europe is dealt with. Other meteorological correlations are referred to. In summing up Wiese's work, Sir Gilbert remarks that while conditions in the Barents Sea do not exercise a profound influence on the conditions of the Southern hemisphere, they are of importance in a fairly wide region of the northern hemisphere.

GOLD IN THE DARTMOOR GRANITE.—In the *Mineralogical Magazine* for March, Dr. A. Brammall describes his investigation of the modes of occurrence of gold on Dartmoor. Detrital gold was first identified in samples of stream-sand and 'head.' A gold-bearing pegmatite on Bittleford Down was then found, and described in collaboration with Dr. H. F. Harwood. Since then gold and silver have been detected in the normal grey biotite-granite at various localities on the Moor. The gold is found as inclusions, sometimes visible, in both quartz and felspar, and together with silver in biotite. The evidence is conclusive that the two metals are primary products of crystallisation from the granitic magma. Careful examination of vein-quartz, and assays of pyrites and of pneumatolysed rock showed that the gold-silver content of the granite cannot be attributed to either pneumatolytic or hydrothermal processes. Similarly occurring primary gold has already been recorded from granites in California and Nevada.

KAMES AND DRUMLINS IN SCOTLAND.—Prof. J. W. Gregory defines 'kames' as ridges of fluvioglacial or glacieluvial sand and gravel, deposited along the margin of a glacier during some halt in its retreat, where the ice front was bounded by water (*Trans. Roy. Soc. Edin.*, vol. 54, pt. 2, No. 7, 1926). As a result of an extensive study of the distribution and structure of the Scottish kames he concludes that they have all the characteristics of marginal formations, like the majority of Irish eskers, and that they give no support to the view that they were formed

along the course of sub-glacial rivers. The term 'kame' has been applied to various formations in Scotland, including moraines, denudation mounds, and even rounded hills of slate. After eliminating these, the typical true kames that remain number only a score, nearly all of them being in the east near the foot of the Highlands. On the west the glacial deposits were laid down as moraines rapidly dumped from melting ice. In a further paper (*Ibid.* No. 8) Prof. Gregory discusses the origin of 'drumlins.' He argues that the trend of the Scottish drumlins shows that they have been moulded mainly by sub-aerial erosion guided by the wind.

ISOSTASY IN NORWAY.—An important paper by W. Heiskanen on the reduction of gravity observations in Fennoscandia has been published as No. 5 of the *Veröffentlichungen des Finnischen Geodätischen Institutes*, 1926. It is shown that in southern Norway the adoption of the Pratt-Hayford hypothesis of isostasy points to a depth of compensation at 80 km., while the Airy hypothesis leads to the deduction of an outer crust having a thickness averaging 37 km. Which of the two rival views is more in accord with the actual results is difficult to determine, but the author favours the Airy hypothesis as being equally well supported by the residual anomalies, and more in accordance with geological and geophysical probabilities. Reference is made to Gutenberg's estimates of the thickness of the earth's crust: under Eurasia (55-60 km.), America (*ca.* 50 km.), the Atlantic (*ca.* 25 km.) and the Pacific (0-5 km.), and these are compared with other determinations based on the Airy hypothesis: in the Alps (41 km.), North America (50-60 km.), and the Caucasus (77-104 km.). The Airy hypothesis thus appears to receive a certain amount of direct support, but it must be admitted that the apparent concordance of some of the figures means very little. Stoneley and Jeffreys have recently pointed out a fundamental source of error in Gutenberg's work, due to the effects of dispersion of seismic waves having been overlooked. The necessary correction reduces the thickness of the continental *sial* layer to about 15 km. This does not, however, invalidate the Airy hypothesis, for the depth of compension need not be identical with that of the *sial* layer. It is interesting and significant that in Europe opinion is steadily veering away from the somewhat artificial Pratt hypothesis followed by Hayford and still adopted in the official American work on isostasy.

COLOUR OF THE ALKALI METALS.—In a short paper communicated to the Vienna Academy of Sciences on February 4, 1926, Prof. Przibram gives an account of the "Interpretation of colour changes in salts." He detects a progressive change in the direction of longer wave-lengths of the absorption produced by atoms of metal in the lattice of a salt at low temperatures, at high temperatures, with a distorted lattice (*e.g.* the colour produced by exposure to radium of salt which has been fused with a small percentage of boric acid), in glass, in colloidal coloured crystals, colloidal solutions, and finally in the vapour. These colour-changes are attributed to a progressive relaxation of the forces which are imposed on the atoms of the metal by the lattice of a salt-crystal; for example, a crystal of rock-salt which is coloured yellow by the presence of traces of the free metal.

ESTIMATION OF ANTI-TETANIC SERUM.—In the 1923–1924 volume of the *Rendiconto della R. Accademia delle Scienze dell' Istituto di Bologna*, Prof. Plinio Bardelli gives the results of a series of experiments showing that the antagonistic behaviour of anti-tetanus serum towards strychnine is determined by the same anti-body as neutralises the tetanus poison. It is therefore suggested that strychnine be used as a means of evaluating anti-tetanic serum. It is true that, in so far as chemical constitution is concerned, there is a wide difference between strychnine and the tetanus toxin, but the effects resulting from the administration of strychnine follow the same course as tetanus, whereas this is not the case with the arbitrary antigen used in the diagnosis of syphilis. Further, the use of strychnine obviates the serious difficulties contingent on the qualitative and quantitative differences of the toxins derived from different strains of the tetanus organism.

AIR/GAS RATIO IN GAS BURNERS.—The subject of the aeration of upright and inverted lighting burners is discussed in the thirteenth Report of the Gas Investigation Committee of the Institution of Gas Engineers. A rapid increase in the degree of aeration accompanies an increase of the gas supply pressure up to 2·5 in. of water, above which any further increase of aeration is relatively small. The amount of air injected as primary air, when the burners are in normal operation, is slightly less than half that required for complete combustion of the gas. The air to gas ratio of the mixture produced by the injection is higher for the upright than for the inverted burner, the burners being adjusted for best illumination. This air/gas ratio is materially reduced as the burner becomes heated, but is not appreciably altered by the use of a chimney. The differential-pressure column method of the Fuel Research Board (Technical Paper No. 5) for the determination of the specific gravity of gases is shown to be accurate to within 0·002 when applied to the ordinary grade of towns' gas supply (specific gravity about 0·5). The fourteenth Report is devoted to a description of an experimental carbonisation plant, comprising settings of two horizontal retorts and two vertical retorts, and the usual condensing and purifying plant, erected at the University of Leeds as a memorial to Sir Corbett Woodall.

HIGH TEMPERATURE STANDARDS.—The issue of part 4 of the *Abstract Bulletin of the Nela Research Laboratory* completes vol. 1 of the Bulletin. Part 4 contains Abstracts 99 to 138 on pp. 523-737 of the volume. The researches to which they refer were carried out under the late Dr. E. F. Nichols, of whom a portrait is given. Many of the abstracts cover papers which have appeared at various times in the scientific and technical press and sum them up in a compact form. Thus abstract No. 108 condenses into 14 pages the results published by the Nela Laboratory in seven different periodicals during the past seven years on the subject of optical pyrometry. One of the most important abstracts deals with an intercomparison of high temperature scales in use at the Nela Laboratory, the Bureau of Standards, the National Physical Laboratory, the University of Wisconsin, and the General Electric Company's Research Laboratory. The temperatures of the filaments of seven incandescent electric lamps run at stated currents were measured at each laboratory and the results compared. Three of the laboratories take the melting-point of gold, 1336°, on the Kelvin scale as the standard temperature, while two others take the melting-point of palladium, 1828° K and 1822° K respectively. The temperatures estimated by the latter laboratory are all 10° to 20° higher at about 2000° K than those of other laboratories, which agree with each other to within 10° at 2700° K.

Application of Subatomic Thermodynamics to Astrophysics.

THE presidential address to the Mathematics and Physics Section of the thirteenth Indian Science Congress held at Bombay on January 4, by Prof. M. N. Saha, contains a résumé of the work of the last few years on the physical interpretation of stellar spectra. We are unable to find space to reproduce the whole address, but the following summary and extracts include some of the main subjects surveyed.

Since the foundations of astrophysics were laid by Kirchhoff in 1859, the spectroscopic survey of the heavens has been carried on with great vigour by many workers, and the spectra of more than 200,000 stars have been classified at the Harvard College Observatory. In the interpretation of the spectra, however, two difficulties have arisen. First, there are several elements, common on the earth, which are not represented in the spectra of the stars; secondly, the elements represented in the stars are not all the same, but vary from one star to another in such a way that a continuous sequence of spectra can be arranged corresponding to a sequence of colour from blue-white through yellow to red. The character of the spectral change along the sequence is that in going from blue to red stars the spectral lines indicate a gradually decreasing excitation stimulus.

Lockyer long ago explained the phenomena by supposing that a spectrum was an indication of temperature, and that in the high temperature blue stars the elements were dissociated into simpler forms. This hypothesis offered a sufficient explanation of the facts, but was unwelcome on account of its revolutionary character. In recent years, however, this criticism has ceased to hold good, and in Prof. Saha's address an "attempt has been made to show how modern discoveries have led us to a complete justification of the main ideas of Lockyer."

When a gas is raised to a high temperature, the violence of the atomic collisions is conceived to result in the detachment of electrons from atoms. At any temperature a state of statistical equilibrium is reached, in which the rate of ionisation is equal to the rate of recombination. The gas then consists of ionised atoms, neutral atoms, and electrons, and at each recombination of an electron with an ionised atom, radiation is emitted. The fraction (x) of dissociation can be calculated in terms of temperature (T) and pressure (P), and is found to be given by the equation:

$$\log \frac{x^2}{1-x^2} \cdot P = -\frac{U}{2{\cdot}3RT} + \frac{5}{2}\log T - 6{\cdot}5 = K,$$

where U is the ionisation potential of the atom and R is the gas constant. The formula, as Russell has shown, needs modification when more than one element is present—a statement confirmed by both experiment and observation—and, further, represents only an approximation to the complexity of an actual case, since the various excited states of the atom have not been distinguished, but it is sufficiently exact to explain the main details of the spectral sequence.

From the observed positions in the sequence at which particular lines appear or disappear (which we may take to indicate the conditions under which the appropriate atoms begin or cease to be capable of emitting the respective lines), the above equation, combined with spectral data, gives a relation between the temperature and pressure in the stellar atmosphere. Assuming a likely value for the latter, the temperature can be estimated, and is found to agree fairly well with the photospheric temperatures measured by direct experiment. This constitutes a justification for the view that ionisation in stellar atmospheres is a function of temperature and pressure. It has long been an unsettled question whether temperature alone can stimulate radiation, but recent experimental evidence indicates very definitely that it can do so. The theory under consideration not only provides for this, but also shows that the failure of earlier experiments was due to the choice of elements having high ionisation potentials, which, according to the equation, require high temperatures for ionisation or excitation. The implication that the degree of ionisation is increased by lowering the pressure is also borne out by experiment. The theory further explains the apparent absence of certain elements from the sun and stars by the argument that their chief spectrum lines under the conditions existing in the atmospheres are outside the range of observation.

Prof. Saha, to whom the theory in the above form is due, points to further evidence of thermal ionisation in the fact that the electrical conductivity of heated gases depends on their ionisation potentials. This at once follows from the theory if the conductivity is due to the presence of free electrons, for it must then be dependent on the percentage of ionisation, which is a function of the ionisation potential.

Later developments of the theory are mainly indebted to applications of subatomic thermodynamics to the problem. Following the lines of Ehrenfest's re-examination of Planck's thermodynamics, Fowler and Milne, Becker, Saha and Sur, have been the chief workers in this field.

"The scope of Fowler and Milne's work will be realised from the following brief summary: As mentioned above, when an original mass of calcium is heated, the products of decomposition are not only ionised calcium atoms and electrons, but also calcium atoms in the excited states, which, being unstable, give rise to the line spectrum of calcium. As the spectrum of calcium is rather complicated we shall take a simpler case, namely, hydrogen. The products of decomposition are then H^+, electrons, H-atoms in 2_1, 2_2, 3_1, 3_2 . . . states, radiation $\nu = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$ constituting the Lyman series, the lines $\nu = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$, constituting the Balmer Series, etc. . . . In the simple theory sketched above, we neglected these intermediate orbits on the ground that even at the highest temperatures, their proportion calculated according to Maxwell's theorem is small.

By applying Ehrenfest's method (which has been improved on mathematical points), Fowler obtains the equation:

$$\log \frac{x^2}{1-x^2} P = K - \log b(T)$$

in place of the original equation. The function $b(T)$ represents the occurrence of the intermediate orbits.

$$b(T) = g_1 + g_2 e^{-\frac{U_2}{kT}} + \ldots g_n e^{-\frac{U_n}{kT}} + \ldots$$

where g_n is the intrinsic weight of the nth intermediate orbit, U_n its energy. According to Bohr $U_n = R\left(1 - \frac{1}{n^2}\right)h$, ($R$ = Rydberg number), and $g_n = n(n+1)$ (according to Herzfeld and Epstein).

It may be mentioned here that $b(T)$ is divergent, and in order to get over this difficulty, Fowler thinks that $b(T)$ ought to be limited to a finite number of

terms. He argues that as the nth orbit has a radius of a_0n^2, the series cannot be developed when the distance between two atoms is of this order, for the electron then passes into no-man's-land. As was pointed out in a note to NATURE, there is strong experimental evidence for believing that the development of higher orbits depends upon pressure (one has to think of Wood's method of getting higher lines of the Balmer series), and this is also supported by astrophysical data (see Miss C. Payne's "Stellar Atmospheres," page 48). Urey has recently shown that $b(T)$ becomes convergent when the finite volume of molecules is taken into account.

But the weak point in the argument is the assumption $g_n = n(n+1)$, and it seems to be unsound on physical grounds.

The conclusions which Fowler, and Fowler and Milne (*Month. Not. R.A.S.*, vol. 83, page 403) have drawn are, however, largely independent of the form of $b(T)$, and are of the greatest importance. It will be recalled that many elements, for example, mercury, have to be detected by subordinate lines, while others like calcium can be detected by principal, as well as subordinate lines. Fowler and Milne discovered a very remarkable difference between the behaviour of the principal and subordinate lines in stellar sequence. They found that while principal lines are most intense at the lowest temperatures, and gradually weaken in the higher classes, the subordinate lines are at first faint, then increase in intensity, reach a maximum, and then die out. The explanation is as follows: At the lowest temperature, all atoms are in the lowest state. Subordinate terms come out only at higher temperatures. But when the temperature is very high, the atom begins to get ionised, and hence the proportion of atoms in the subordinate states begins to fall off. A maximum must have been reached in the interval.

When the above ideas are translated into mathematical language, and conditions for maximum concentration of subordinate levels applied, we get a relation connecting the electron pressure and the temperature in the reversing layer. In fact

$$P_e = \frac{0{\cdot}332}{b(T)} \cdot \frac{U_r + \frac{5}{2}RT}{U_1 - U_r} T^{5/2} e^{-\frac{U_1}{kT}} \quad . \quad . \quad . \quad (1)$$

For example, the Balmer-lines of hydrogen arise from the 2-orbit, and they reach their maximum in the A-class. The temperature of these stars lies between 10,000° K to 12,000° K. Substituting these values in (1), we obtain $P_e = 1{\cdot}31 \times 10^{-4}$ to $3{\cdot}07 \times 10^{-3}$ atmospheres.

Fowler and Milne have thus found a very elegant method of determining the pressure. This is in itself a result of the first magnitude, for ionisation depends very largely on pressure, and after Einstein's discovery of the shift of lines towards the red by gravitational potential, the older values which were based on pressure-shift of lines have been rendered obsolete.

Values of P_e have been calculated from considerations of the maxima of several elements, and they invariably give a range of pressure varying from 10^{-3} to 10^{-5} atmospheres. These values recall the statement of Jewell; 'The whole mass in the reversing layer of the sun can be contained in a thimble.' . . .

Prof. Milne has recently given an entirely new method of dealing with thermal ionisation of gases. In contradistinction to the thermodynamical method hitherto used, this method may be called the kinetic method. These two methods find their parallel even in the study of chemical equilibria. Let us represent a typical homogeneous equilibrium by the equation

$$mA + nB \rightleftarrows pC + qD.$$

Then according to the thermodynamical method we put

$$mS_A + nS_B - pS_C - qS_D = \frac{U}{T},$$

where S's are the entropies, and U is the heat of reaction.

In the kinetic method, the rate of change from left to right depends on the number of times m molecules of A come into contact with n molecules of B. The velocity of reaction $V_{AB} = K_1C_AC_B$, and $V_{CD} = K_2C_CC_D$. In the equilibrium case

$$V_{AB} = V_{CD}, \text{ hence } \frac{C_AC_B}{C_CC_D} = \frac{K_2}{K_1} = \text{constant}.$$

By using this method, Boltzmann gave a formula for molecular dissociation, which has the same form as that derived from thermodynamics.

Thermal ionisation of gases is only a particular form of chemical dissociation with the difference that the details of the mechanism are much better understood in the former case. Hence it is expected that the kinetic method would be very fruitful here.

Every kinetic method depends upon a closer treatment of the mechanism of reaction. The reaction in the present case is decomposition of M into M^+ and e (electron), and this can take place in various ways. To any one of these processes there is an opposite process resulting in recombination of M^+ and e to M. A pair of such oppositely directed processes has been called by R. H. Fowler 'a unit mechanism.' Each one of these unit mechanisms, by itself and without the aid of any other process, would give us some fundamental laws of general validity. This is known as the 'principle of detailed balancing.'

The ionisation of M-atoms placed in a thermal enclosure can occur:

(a) As a result of collision of two H atoms; the rate of ionisation is then proportional to the square of pressure.

(b) As a result of absorption of radiation by H atoms, normal as well as excited.

Thus, according to Bohr's theory, radiation of frequency higher than $\nu = \frac{R}{1^2}$, when falling on the normal hydrogen atom, would completely ionise it. If the electron is in the 2-state, radiation shorter than $\nu = \frac{R}{2^2}$ would ionise the atom. Such a process of ionisation may be called photoelectric ionisation. This is true of every element, and in the case of alkalies it has been definitely proved that their vapours are ionised by radiation shorter than that corresponding to the limit of the principal series.

The reverse processes are:

(a') Process (a), ionisation by collision is radiationless. The reverse process of capture when M^+ and e come together must also be radiation-less. Hence when M^+ and e combine together, the energy set free must be carried away by a third body. Hence the reverse process to (a) is a three body encounter between M^+, e, and M (or e), the energy liberated being carried off by M. The unit mechanism (a), (a') has been studied by R. H. Fowler in an extension of the ideas of Klein and Rosseland on the so-called collisions of the second type.

(b'), the reverse process to (b), must naturally be the capture of an electron by the ion M^+, with liberation of radiant energy. But Milne finds that (b) and (b') together do not give the law of reaction isochore. So he postulates that electrons may be

captured even under the influence of radiation. This last process is analogous to Einstein's 'Negative Einstrahlung' or stimulated emission. Thus we may write—

Rate of photoelectric ionisation = Rate of capture with emission + Rate of capture under the influence of radiation.

Compare this with Einstein's well-known method of deducing the law of black body radiation :

Rate of absorption of light = Rate of spontaneous emission + Rate of emission under the influence of radiation.

With the aid of certain assumptions, Milne calculates the rates of free and stimulated captures and equates it to the number of photoelectric ejections. The equation may be used in two ways. It may be employed to evaluate the degree of ionisation, in which case some further assumptions are necessary. Conversely, assuming the thermodynamic formula for ionisation, it can be used for finding out the law of probability of electron capture. In this way Milne arrives at the conclusion previously reached by Eddington in his study of opacity of stars, namely, that the electron is captured only when it actually hits the nucleus. Probably a more rational way of expressing the result would be: Only one in 10^5 collisions results in a capture.

Applied to hydrogen, calcium, and mercury, Milne's method furnishes values of absorption coefficients which are in general agreement with experimental values.

It is yet too early to predict how far Milne's method in its present form will be able to advance the theory of thermal ionisation. The great difficulty which is encountered in the development of these methods is due to the absence of any suitable quantum theory of absorption of lines. The present theories are a sort of half-hearted compromise with the old Lorentz theory which ascribes absorption to damping produced by collision."

The Sea-Urchins of New Zealand.

By H. FARQUHAR, Wellington, N.Z.

THE following notes were written some time since, but were held back until Dr. Mortensen had published his zoogeographical notes on New Zealand echinoderms (*Vidensk. Medd.*, Bd. 79, 1925). They are now given here because the subject is approached from a different point of view; namely, that of the New Zealand biological region; and also because I find myself obliged to differ from him on some points. For example, Dr. Mortensen believes that Wegener's hypothesis of continental displacement "gets support also from the study of the New Zealand Echinoderm fauna"; while I am of the opinion that the evidence of our fauna and flora at large, including the littoral, is strongly against Wegener's hypothesis as regards Australia and New Zealand; and that it mainly agrees with the evidence of the micro-Lepidoptera as stated by Mr. E. Meyrick in NATURE of May 30, 1925. The more I have learnt of the New Zealand fauna and flora in general, and particularly of several small groups, the more I have been impressed by the great fundamental differences between the faunas and floras of the two regions; and, as Meyrick says, "The amount of community shown here is then no greater than might be expected if the conditions had always been as at present," etc. When we remember, moreover, that the New Zealand land-area was greatly elevated and extended far to the north-west in early Tertiary times, and, again, to a less extent perhaps, later, we may well be surprised that the affinities are not much stronger.

Reasons for the recognition of the New Zealand area as a primary zoological region were set forth in NATURE of January 11, 1900. Objections by Mr. Wallace were given in the issue of January 18, and support by Prof. Alfred Newton and Mr. Hedley in the issue of January 25, and April 19, respectively. In a letter to me, at that time, Prof. Newton wrote, "I have no doubt that the littoral marine fauna has also an exceedingly interesting story to tell"; and as the several groups of the littoral come to be worked and revised the more distinctly and clearly does this "interesting story" become known. In the preface to his "Manual of N.Z. Mollusca," 1880, that keen and indefatigable observer, the late Capt. Hutton, said, "The better the fauna of New Zealand becomes known, the more prominently does it stand out distinct from that of any other country"; and this is now being verified by all New Zealand naturalists. What makes the history of our plants and animals especially interesting and important is that this area is a *biological* region of primary rank (Holloway, *Trans. N.Z. Inst.*, vol. 55, p. 67; Cockayne, "New Zealand Plants and their Story," etc.), for here and here only the botanical region is coterminous or almost coterminous with the zoological region; and the evidence of the botany, zoology, geology, palæontology, the physical conditions of the land, and the form of the sea-bed all harmoniously contribute to the wonderful past history and present status and character of this remarkable region.

Of course the littoral marine fauna does not speak so clearly and forcibly as the land fauna, for species of some of the groups (hydroid zoophytes, mollusks, echinoderms, etc.) have recently been widely spread by oceanic currents, but the evidence, in the main, agrees with that of the terrestrial plants and animals.

The New Zealand sea-urchins have been recently revised and the number of known forms increased by Dr. Mortensen of the Copenhagen Museum (*Vidensk. Medd.*, Bd. 73, 1921); and Dr. H. L. Clark of the Museum of Comparative Zoology has given an excellent classification of the group, based upon all the light of recent research, in his "Catalogue of the Recent Sea-urchins in the British Museum," 1925. The littoral forms are those which inhabit the area lying between high-water mark and the hundred-fathom line (the continental shelf). Large portions of this zone are entirely unknown, and many more species will by-and-by be added to our list, which at present consists of 22 forms :

1. *Goniocidaris umbraculum*, Hutton.
2. *Austrocidaris benhami* (Mortensen).
3. *Cidaris sp.* (Young), Mortensen.
4. *Arœosoma thetidis* (H. L. Clark).
5. *Amblypneustes ovum* var. *pachista*, H. L. Clark.
6. *Holopneustes inflatus*, A. Agassiz.
7. *Pseudechinus albocinctus* (Hutton).
8. *Pseudechinus novœzealandiœ* (Mortensen).
9. *Pseudechinus huttoni*, Benham.
10. *Pseudechinus variegatus*, Mortensen.
11. *Pseudechinus grossularius* (Studer).
12. *Evechinus chloroticus* (Valenciennes).
13. *Heliocidaris tuberculata* (Lamarck).
14. *Clypeaster virescens*, Döderlein.
15. *Arachnoides zelandiœ*, Gray.
16. *Peronella hinemoœ*, Mortensen.
17. *Laganum depressum*, Agassiz?
18. *Echinocyamus polyporus*, Mortensen.
19. *Apatopygus recens* (Milne-Edwards).
20. *Brissopsis zealandiœ*, Mortensen?
21. *Spatangus multispinus*, Mortensen.
22. *Echinocardium cordatum* (Pennant).

The three known species of the first order of Echini (Cidaroida) appear to be endemic. *Goniocidaris umbraculum* is nearly related to the two Australian forms, *geranioides* and its variety *Kubaria*, of this small, southern, littoral genus, as now restricted. The three species belong to closely allied genera of a widespread, very ancient group, the Cidaridæ. The young Cidaris described by Dr. Mortensen may be the young of a known form, but is more likely that of an undescribed species.

Of the second order (Diadematoida) there are ten known forms. The first of these, *Arœosoma thetidis*, which occurs also off the south-eastern coast of Australia, is a species of a prosperous, widespread genus, the home of which is in deeper water. The specimens were obtained from 70 fathoms, and it is evidently a migrant from the continental slope. The two forms *Amblypneustes ovum* var. *pachista* and *Holopneustes inflatus* belong to a very interesting but difficult group (the Temnopleuridæ). These two genera are wide-ranging and closely related; and both species occur freely on the eastern and southern coasts of Australia; and have doubtless come thence. The next group consists of five endemic species of the essentially New Zealand genus Pseudechinus. Only one other species is known (*P. magellanicus*) from the southern coasts of South America, the Crozet and Marion Islands. It is closely related to *P. albocinctus*; and it has no doubt drifted from New Zealand. All its stations are in the area of distribution of the seaweed *Macrocystis pyrifera*. Hawkins has noted that two species, *P. albocinctus* and *P. novœzealandiœ*, have been found in raised beaches of probably Pleistocene age. *Evechinus chloroticus* is the commonest New Zealand urchin; and the genus is monotypic and endemic. The other species of the family Strongylocentrotidæ, *Heliocidaris tuberculata*, is a warm-water form, a migrant from the north, which occurs freely on the north-eastern coast of Australia and at the Kermadecs.

Of the third and last order, the irregular urchins (Esocyloida), nine species have been found in New Zealand. *Clypeaster virescens* belongs to a large genus, widely spread in the Indo-Pacific region. The specimens were collected north of New Zealand, and it is evidently a migrant from the north. *Arachnoides zelandiœ* is an abundant, endemic, rather ancient (Pleistocene) form; and the only other living species of the genus, *A. placenta*, is widely diffused in the Indo-Pacific region. Of the two species of the Laganidæ, *Peronella hinemoœ* is endemic, and closely related to a Japanese species,[1] *P. pellucida*; and the other has been referred to *Laganum depressum*, an Indo-Pacific species, but its identity is doubtful. *Echinocyamus polyporus* seems to be a rare species of a northern genus, which has been found in Cook Strait and at the Kermadecs.

We come now to the most interesting of all the New Zealand echinoderms, *Apatopygus recens*. It occupies in the littoral much the same position as the Tuatara (*Sphenodon punctatus*) in the land fauna; being the only living representative of a group which was abundant and widely distributed in Mesozoic times. Prof. Hawkins has examined specimens, and he tells us that "the original contention that '*Nucleolites*' *recens* is a latter-day survival of the essentially Mesozoic Nucleolitoida is perfectly justified. . . . Save for its ambulacral plating *Apatopygus* would not have been out of place on a Middle Jurassic beach" (*Geol. Mag.*, 1920, vol. 57, p. 396).

Of the three Spatangoids, *Brissopsis zealandiœ* may be endemic, but its identity is doubtful. *Spatangus multispinus*, an endemic species, belongs to a widespread, northern genus; and *Echinocardium cordatum* is interesting on account of its remarkable discontinuous distribution. It occurs freely, and is widely spread in the littoral of both the northern and southern temperate zones. The only other echinoderm which has a similar distribution is the little brittle-star *Amphipholis squamata*.

The facies of the New Zealand littoral echinoid fauna is then eminently Neozealandian, with a strongly marked distinctive character.

[1] There is a considerable element in the New Zealand littoral marine fauna nearly related to that of Japan; and one of the extremely interesting questions to be decided by future research, is how this has come about.

Annual Meeting of the British Science Guild.

THE annual meeting of the British Science Guild was held at the Mansion House, London, on April 29. The Right Hon. Lord Askwith, president of the Guild, who opened the proceedings, moved the customary resolution that the Right Hon. the Lord Mayor of London be elected a vice-president of the Guild.

Sir Richard Gregory, chairman of the executive committee of the Guild, then moved the adoption of the annual report, and directed attention to some of its salient features. Reference was made to the establishment of the Norman Lockyer Lecture as an annual event. The first lecture, delivered by Sir Oliver Lodge on November 16, 1925, dealt with "The Link between Matter and Matter." It was mentioned that a supplement to the "Catalogue of British Scientific and Technical Books" (a second edition of which was published in June 1925) is in preparation. Further progress has been made, in collaboration with other bodies, with a Science Publicity Service scheme, which has now been confided to a representative committee. It is hoped to report on the cost of establishing and maintaining the service, and the prospective revenue to be derived from endowment or payment for contributions, at an early date, at a further conference of representatives of leading scientific and technical societies. A memorial was forwarded to the Board of Trade during the past year referring to the importance of scientific qualifications for a Comptroller of H.M. Patent Office. It may be permitted to hope that this memorial, signed by many who are well known in pure and applied science, had some influence in deciding the recent appointment to this important post. Additions to the membership of the Guild have been encouraging, and useful work has been carried out by the South Australian Branch during the past year.

The resolution was seconded by Mr. F. Twyman, who alluded to important recent developments in pure science in Great Britain, and to the growing recognition of the value of applied science, as illustrated by the public interest aroused in the recent Optical Convention.

This resolution having been declared carried unanimously, Sir Richard Redmayne spoke on "The Future of the Coal Mining Industry." After pointing out the vital importance of devising a satisfactory scheme for the maintenance of this national key-industry, Sir Richard paid a tribute to the valuable summary of the position contained in the recent report of the Royal Commission. He pointed out

that the depression in the coal industry is universal. Germany is experiencing bad times. In the United States—which produced annually 500 million tons of soft coal (nearly twice the amount obtained in Great Britain) and where the output per man is four times what it is here—the position likewise gives ground for concern. On an average, the miner worked for only 179 days of the year during 1923. There are about 14,000 mines worked by more than 12,000 corporations or individuals.

In this depression the competition of oil-fuel is only a minor factor. It has been shown that the present methods of conducting the industry are unscientific, that selling, organisation and transport are too complex, and that many undertakings are using obsolete and inefficient machinery. Such changes as the wider use of electricity and the burning of low-temperature coke in grates can only be expected to effect partial relief. The real remedy lies in consolidation and scientific organisation of the industry, and the elimination of present wasteful methods. As an illustration of what organisation can accomplish, Sir Richard quoted the experience of the United States Steel Corporation, which by making use of the economies and possibilities of scientific method arising from consolidation, has raised the American steel industry from a position of great depression to one of great prosperity. The formation of this 'trust' has not prevented friendly rivalry between its constituents, and has led to much better relations between management and employees, who are given opportunities of taking up common stock in the concern on favourable terms.

Sir Richard therefore suggested that the solution of the problems of the coal industry lay in consolidation, involving the closing of inefficient pits and the general introduction of better organisation and more scientific methods; the industry should be controlled by an executive council, meeting daily, on which there should be workers' representatives appointed. Methods of profit-sharing for the benefit of employees should be introduced, and the Government might arrange a loan, under the Trades Facilities Act, to tide over the period of reorganisation.

Dr. E. F. Armstrong then spoke on "Dyestuffs." He recalled that the first synthetic dyestuff was an English discovery. The development of the industry in Germany was due to the fact that commercial leaders, having scientific training, encouraged the application of scientific methods and results. The War demonstrated the importance to Great Britain of maintaining an organic chemical industry. Considering the circumstances, the progress so far made in the dyestuff industry in England has been a real achievement. A highly technical industry had to be built up from the beginning. To-day by far the larger portion of the hundreds of known dyestuffs are manufactured here in adequate quantity, and the standard reached is higher than that of the Continent in pre-War days. Economic difficulties have to be contended with, but substantial improvement is expected in the near future. Apart from the production of colours, described as "a miracle of applied science," manufacturers maintain a complete technical service to aid users in their application.

Capt. P. P. Eckersley, who discussed "Broadcasting and the Electrical Industry," remarked that science must be applied on a scientific method. If wisely used it is of priceless benefit to mankind; if wrongly used it may prove a curse. The electrical industry presents many examples of science properly applied. British engineers combined ingenuity and solidity in their work. He agreed that we are apt to be conservative in regard to consolidation, and referred to the British broadcasting service as a shining example of the benefits of judicious amalgamation. Ninety per cent. of people in the British Isles can listen to programmes with the help of inexpensive sets. The smoothness with which programmes are conducted, the manner in which an address by a public man in any part of the country can be broadcast at short notice, and the quality of the programme, are due to the consolidation of all interests in the public service. In the United States, where private interests may dominate broadcasting in some areas and disagreement between competitors may arise, the conditions are less perfect from the point of view of the public. Whatever change may be made in the control of the B.B.C. the fundamental methods will remain the same as at present.

A vote of thanks to the speakers, and to the Lord Mayor for the use of the Mansion House for the meeting, was proposed by Lady Lockyer and carried with acclamation. Lady Lockyer mentioned that meetings had been held in the Mansion House for the last eleven years, each Lord Mayor in turn being elected a vice-president of the Guild.

University and Educational Intelligence.

CAMBRIDGE.—It is announced that Prof. E. T. Whittaker, of Edinburgh, will on May 10 deliver a lecture on "The Present State of the Theory of Light."

A change in the scheme of studies qualifying students for the Ordinary B.A. degree is proposed; by it the much-debated subsidiary subjects should be rendered more effective than at present.

The Board of Extra-Mural Studies is proposing to add to the status of the lecturers and tutors who give instruction on its behalf at various centres throughout the country. The proposals recommend that such persons shall in future be appointed by grace of the Senate on the nomination of the Board, and further, that they shall come under the contributory pensions scheme for university officers. These proposals should lead to the strengthening of the position of these teachers and would be one step in the advancement of extra-mural work, an activity of the University with which the Royal Commission has shown much sympathy.

Two Robert Blair fellowships of 450*l.* each are being offered by the London County Council to adult students of British nationality. They will enable the holders to go abroad for a year for advanced study or research in scientific and manufacturing processes. Applications should be made to the County Hall, Westminster Bridge, London, S.E.1.

APPLICATIONS are invited by the Salters' Institute of Industrial Chemistry for a limited number of fellowships for chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry. The normal value of each fellowship is from 250*l.* to 300*l.*, but applications for grants of a higher value would be considered. The latest date for the receipt of applications is June 1. They should be addressed to the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

IN the University of Dacca, which was opened on July 1, 1921, the principles of a number of the recommendations made by the Calcutta University Commission of 1917–19 have been subjected to the test of practical application; with what success may be gathered from a farewell address delivered by Sir

Philip Hartog, the first Vice-Chancellor, at a meeting of the University Court last November. Chief among these principles is the residential organisation combined with a tutorial system. At Dacca three halls have been established on the lines, so far as possible, of the Oxford and Cambridge colleges, and in each of them have been started literary and debating societies, athletic societies, and social service leagues. Later a University Union was created. Whilst these halls and societies form valuable schools for character training and citizenship, the most important new element on the teaching side is the tutorial work, with the corresponding practical work supervised by the teachers in the laboratories. Much attention has been devoted to the physical welfare of students, and the executive council has decided that physical exercises ought to be compulsory for all students who are not medically unfit. There has been a notable increase in the number of Mohammedan students, from 170 out of a total of 1075 in 1921, to 353 out of a total of 1487 in 1925. The institution of the Dacca Board of Secondary and Intermediate Education, in accordance with the recommendations of the Calcutta University Commission, has not, so far, led to as much improvement as was expected. Experience has shown the need of a practical test at the intermediate examinations in science, but its introduction has been postponed *sine die*. Sir Philip Hartog remarks that the Board should be so constituted that the financial stability and progress of the educational institutions with which the members are connected would not depend on the passing of any particular number of candidates.

THE United States Commissioner of Education's report for 1924–25 concludes a tale of varied and multitudinous activities with the statement that the Commissioner travelled 43,444 miles and made 157 addresses before audiences aggregating 87,410. Specially impressive is the list of publications of the Bureau of Education, comprising, in addition to fifty-eight bulletins and the periodical *School Life*, numerous special series of leaflets relating to city schools, commercial education, health education, home economics, home education, industrial education, and other matters, library leaflets, reading courses, rural school leaflets, etc. The Commissioner devotes a large share of his attention to rural education, and undertook during the year in this connexion a new type of activity, namely, co-operation on an extensive scale with selected educational organisations for the co-ordination and conduct of educational research studies. In addition, he caused a large number of special studies to be made of various aspects of the work of rural schools. His Home Education Department conducts reading courses with the co-operation of State universities or the State library commission or State normal college. The scope of the work seems to be very much on the lines of that of the National Home Reading Union in Great Britain; 1522 readers were enrolled during the year, and the number of readers who have at some time enrolled exceeds 18,500. In view of the notoriety of Tennessee's legislation on the subject of the teaching of the doctrine of evolution, it is interesting to note that a report of a survey by the Bureau's Division of Higher Education directed attention to the low proportion of the college population in that State, the inadequate financial support of the colleges, the lack of co-operation between colleges conducted under the auspices of the same Church denomination, low rates of tuition, inadequate preparation of the faculties of some institutions, and the small attendance of students from counties difficult of access.

Contemporary Birthdays.

May 8, 1858. Sir Bertram C. A. Windle, F.R.S.
May 9, 1877. Sir James C. Irvine, F.R.S.
May 13, 1854. Dr. Marie Yves Delage.
May 13, 1857. Sir Ronald Ross, K.C.B., F.R.S.
May 13, 1851. Sir Horace Darwin, K.B.E., F.R.S.

Sir BERTRAM WINDLE, professor of anthropology in St. Michael's College, University of Toronto, was educated at Repton and the University of Dublin. Before his activities were transferred to Canada, he was professor of anatomy and anthropology in the University of Birmingham; afterwards president of University College, Cork, and whilst resident in Ireland, was much concerned with schemes of Irish education. Apart from scientific memoirs, Sir Bertram is the author of many informing books in general archæology and anthropology, including "The Romans in Britain" (1923).

Sir JAMES IRVINE was educated at Allan Glen's School, Glasgow, and the Universities of St. Andrews and Leipzic. Formerly professor of chemistry and Director of the Research Laboratory at St. Andrews, he is now Principal and Vice-Chancellor. He is an authority on the constitution and chemistry of sugars. Continuing the researches of Emil Fischer, and in collaboration with the late Prof. Purdie, he evolved new processes of investigation relating to these important natural products. Sir James was awarded the Royal Society's Davy medal last year in recognition of his work.

Dr. YVES DELAGE, professor of zoology in the Faculté des Sciences, Paris, and director of the Marine Biological Laboratory at Roscoff, was born at Avignon. He is an Officer of the Legion of Honour and a member of the Paris Academy of Sciences. Leaving teaching work at Caen (1886) he succeeded the late Prof. Milne Edwards in his professorial chair. Dr. Delage is the author of numerous monographs in experimental and general biology.

Sir RONALD ROSS, director of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, received his medical training at St. Bartholomew's Hospital. Qualifying in 1881 for the Indian Medical Service, he served until 1899. It was a period fruitful in biological achievement. Following up some suggestions offered by the late Sir Patrick Manson, investigations were begun by Ross in 1895, in India, with the view of determining the life-history of the parasite of malaria (discovered by Laveran) and the transmission of infection. Ross was able to indicate the cycle of changes of the malarial organism in the tissues of a mosquito (Anopheles) which had been fed on the blood of a malarial patient. His work is the basis of modern methods for the prevention of malaria. Sir Ronald is a Nobel laureate, and a Royal medallist of the Royal Society.

Sir HORACE DARWIN may be, not inaptly, termed the apostle of methods of instrumental precision. Receiving his early training at Messrs. Eastons and Anderson, Erith, Kent, he graduated at Trinity College, Cambridge. He is chairman of the Cambridge Scientific Instrument Company, Ltd. Sir Horace gave the first Wilbur Wright Memorial Lecture before the Aeronautical Society in 1913 on "Scientific Instruments: their Design and Use in Aeronautics." It was prefaced by some interesting considerations respecting birds, the flight of insects, and 'winged plants.' Sir Horace was a member (1915 onwards) of the Munitions Inventions Panel.

Societies and Academies.

LONDON.

Royal Society, April 29.—C. H. **Best**, H. H. **Dale**, J. P. **Hoet**, and H. P. **Marks**: Oxidation and storage of glucose under the action of insulin. Under the same conditions as those of the following investigation, the total quantity of glucose disappearing from the system under insulin is always equal to the sum of the equivalents of the glycogen deposited and of the oxygen absorbed. The conclusion is drawn that all the glucose disappearing under the action of insulin is either oxidised or deposited as glycogen. The fact that, in the normal animal treated with a fatal dose, the end result is often a disappearance of pre-existent glycogen, with concurrent fall of respiratory metabolism, is attributed to the other action of insulin, in depressing the new formation of carbohydrate in the liver. It is accordingly suggested that insulin in excessive doses produces the same effects as in physiological doses, but with abnormal intensity.—C. H. **Best**, J. P. **Hoet**, and H. P. **Marks**: The fate of the sugar disappearing under the action of insulin. When the blood sugar of the eviscerated spinal preparation is kept at a high level for from two to five hours, by the intravenous administration of dextrose, there is no demonstrable change in the glycogen content of the skeletal muscles. When a hyperglycæmia is maintained and insulin is administered, no significant part of the sugar which disappears is stored as a phosphate ester in the skeletal muscles. Under these latter conditions, however, there is an increase of glycogen in the muscles sufficient to account for from 40 to 50 per cent. of all the sugar which disappears. When the rate of sugar infusion is so slow that the blood sugar reaches a very low level under the action of insulin, the muscle glycogen is not depleted to form some unknown substance. When sufficient sugar has been available there is a recognisable increase in glycogen. Similar results are obtained when the spinal preparation has not been eviscerated. Hypoglycæmic convulsions, which are eliminated in the spinal preparation, produce a great depletion of the glycogen content of the skeletal muscles.—J. P. **Hoet** and H. P. **Marks**: Observations on the onset of rigor mortis. The precipitate rigor mortis observed in rabbits dying after hypoglycæmic convulsions, or after prolonged thyroid feeding, is not due to the accumulation of the lactic acid, nor to increased acidity of the muscle. The absence of glycogen and the decrease in lactacidogen of the muscle are the determining factors of this rigor. These facts must be taken into account in discussing rigor mortis and also muscular contraction.—J. C. **Mottram**, G. M. **Scott**, and S. **Russ**: On the effects of β-rays from radium upon division and growth of cancer cells. Tumours growing in rats were exposed to measured doses of β-rays from radium. After various intervals, small pieces of the tumours were removed and counts made of the number of cells in a state of division. Immediately after a dose of radiation large enough to prevent growth of the cells *in vivo*, many cells were found in a state of division, but very soon the cells in mitosis disappeared. When irradiated tumours were left in the rats for some days after the irradiation, there was some return of cells in division, even after very large doses. The variation in the results with the interval between irradiation and examination is intimately bound up with the varying susceptibility of the cells at different stages in their growth.

DUBLIN.

Royal Irish Academy, April 12.—J. J. **Nolan**: The breaking of water-drops by electric fields. Falling drops were exposed to a transverse electric field. It was found that explosive bursting of the drops occurred at critical values of the field, the relation between the field and the radius of the drop being $F\sqrt{r} = \text{const.}$ This is in agreement with the observations of C. T. R. Wilson and G. I. Taylor on soap-bubbles. Drops greater than 0·2 cm. radius showed a type of disintegration for lower values of the electric field than those required to produce explosive bursting. Attempts to determine the ballo-electric charge developed by the bursting of the drops were unsuccessful.

PARIS.

Academy of Sciences, April 7.—Georges **Claude**: The present state of ammonia synthesis utilising coke-oven gas. Reasons are given for the use of the hydrogen from coke-oven gas in the synthetical preparation of ammonia. Photographs are given of the works at Waziers and at Ougree. The preliminary difficulties have been to a great extent overcome, and works using the Claude process in the last quarter of 1925 produced 10,000 tons of sulphate of ammonia or its equivalent.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: Viscosity and turbulence.—Max **Morand**: The luminous phenomena observed in a lithium positive-ray tube.—J. **Cabannes** and J. **Granier**: The depolarisation of light diffused by some organic substances.—G. **Bruhat**: An apparatus for the precise determination of the orientation of a rectilinear vibration in the ultra-violet.—A. **Cotton**: Remarks on the preceding communication.—S. **Schlivitch**: Photovoltaic batteries with unalterable electrodes.—Ch. **Courtot** and C. **Pomonis**: Study in the diphenylene sulphide series. Details are given of a method of nitrating diphenylene sulphide and of the reduction of the nitro product to aminodiphenylene sulphide.—J. Roger **d'Ansan**: Remarks relating to the application of ocular gymnastics to the treatment of myopia and amblyopia.

CALCUTTA.

Asiatic Society of Bengal, April 5.—C. de Beauvoir **Stocks**: Folk-lore and customs of the Lap-chas of Sikhim. A translated collection of Lap-cha myths and fairy-tales, supplying an analysis of the ancient religion. The customs and superstitions of the different aspects of Lap-cha life and industries show they are connected with the traditions of a pre-Buddhist faith.—S. L. **Hora**: A short note on the distribution and habits of *Balwantia Soleniformis* (Benson). This bivalve lives in burrows excavated either in hard blue clay or in friable sandstone. The species is common in the Daleswary and the Barak rivers in Cachar. It lives in a burrow firmly anchored by its foot at the anterior end, and is enabled to enlarge it by a movement caused by the expansion and contraction of the foot. The Uriya coolies consider the animals of this species as a great delicacy and have devised an instrument for dislodging them from their burrows.—J. H. **Hutton**: Diaries of two tours in the unadministered area east of the Naga Hills. Notes of a tour made by Mr. J. P. Mills and the author in 1923 to a part of the Naga Hills which, so far as known, has never been visited by any European except by Lt. (afterwards General) Woodthorpe in 1876.—D. N. **Majumdar**: Marriage and betrothal amongst the Hos of Kolhan.—W. **Ivanow**: Rustic

poetry in the dialect of Khorasan. The grammatical peculiarities of the Persian dialect spoken in the province of Khorasan are discussed, together with a large collection of rustic songs from the district of Sabzawar.—Hem Chandra **Das-Gupta**: A few types of sedentary games prevalent in the Punjab. Description of six games played with pieces on diagrams inscribed on rock-slabs or improvised on other material: (1) Dō-guti (two gutis or pieces); (2) Treguti (three pieces); Naō-guti (nine pieces); (4) Sherbakar (tiger and goats); (5) Ratti-chitti-bakri (red-white goats); (6) Khutkā boiā (dug circles). The first two have, as far as known, nothing similar in other parts of India; the third has parallels in Bengal; the fourth in Bengal and Orissa; the fifth in Sumatra; the sixth in Assam, Orissa and Madras.

ROME.

Pontificia Accademia delle Scienze (Nuovi Lincei), March 21.—**Teofilato**: Some questions of ballistics. —**Martinelli**: The annual (for 1926) of the prediction office of the Ministry of Aeronautics, containing numerous notices referring to tides, terrestrial magnetism, atmospheric pressure, etc.—**Scatizzi**: The polar and essential singularities of a summable derivative with variable index.—**Neviani**: The fossil hippopotamus of the Roman Campagna: notes on new discoveries, and bibliography.—**Gianfranceschi**: Certain considerations on the numerical results obtainable with the author's formula for the distribution of energy in the black body spectrum.—Ludovici **Marini**: Climatic notes on Corfu.

Royal Academy of the Lincei, March 7.—G. A. **Crocco**: Possibility of super-aviation. The possibility of extra-atmospheric navigation is considered, and it is shown that if the weight supported is constant the power necessary for horizontal flight is proportional to the velocity, but independent of the altitude, of the flight. Further, for a given initial weight and a constant specific consumption, the amount of fuel necessary to cover a definite distance in horizontal flight is independent of both the altitude and the velocity.—R. **Nasini**: The volatility of orthoboric acid in steam. The recent denial by Anschütz and Riepenkröger that orthoboric acid is volatile in water vapour disagrees with the results of other investigators. This acid may be distilled in steam at reduced pressure if the temperature does not fall below 60°; at higher temperatures it volatilises even at the ordinary pressure. O. M. **Corbino**: The electronic theory of thermo-magnetic phenomena. The Lorentz and Gans theory, when applied to the case of a disc traversed by a centrifugal radial current of heat or electricity, predicts the formation of a circular thermo-magnetic or galvano-magnetic current of the same sense as the current producing the magnetic field. This result is, however, contrary to the truth for both currents with all metals (including bismuth) with the exception of gold, silver and copper. The theory of Livens would permit of the elimination of the contradiction in some instances, but the law of distribution of velocity on which it is founded is not in accord with the laws of electromagnetism.—S. **Franchi**: Gradual change to crystalline calc-schist and marble forms of the fossiliferous Nummulitic and Cretaceous in the Val del Gesso and the Val della Stura di Cuneo.—A. **Russo**: Mixed individuals and gametogens, neutral individuals, and pre-conjugants in the biological cycle of the ciliates, in relation to those of the metazoa.—Vasco **Ronchi**: Recent theories of flying shadows. This phenomenon is explained in the most natural and exhaustive manner by the illumination of the non-homogenous atmospheric stratum by the highly brilliant solar crescent.—A. **Rosenblatt**: Regularisation of the problem of three bodies.—A. **Ferrari**: Comparison between the diameters of the ions of one and the same element, but with different charges. The diameters of quadrivalent manganese and lead ions are respectively 2·50 and 3·10 Å.U., whereas those of the corresponding bivalent ions are 2·95 Å.U. and 3·80 Å.U.—B. **Monterosso**: Structure of *Peroderma cylindricum*, Heller.—Alberto **Chiarugi**: Phenomena of apospory and apogamy in *Artemisia nitida*, Bertol. —Umberto **D'Ancona**: Contribution to the histophysiology of striated muscle fibre.

VIENNA.

Academy of Sciences, March 18.—W. **Dorn**: Fourier's integrals considered as limiting cases of Fourier's series.—O. **Abel**: Morphological investigations on the styloid bones of horses.—M. **Belar**: Communication from the Radium Institute, No. 186. On the coloration of rock-salt by Becquerel rays.—K. **Przibram**: On the theory of the coloration of rock-salt by Becquerel rays.—E. **Flatt**: Regeneration of the long bones after partial removal in the interior of the extremities of the newt (*Triton cristatus*).—M. **Kohn** and G. **Dömötör**: The behaviour of the penta-halogen-phenols to aluminium chloride in the presence of benzole (Communication No. 20 on bromo-phenoles).

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 2, No. 13: Partial Differential Equations and the Calculus of Variations. By E. T. Copson. Pp. 126-135. 1s. Vol. 46, Part 2, No. 14: The Distribution of Electric Force in High Voltage Discharges. By Dr. A. E. M. Geddes. Pp. 136-148. 1s. Vol. 46, Part 2, No. 15: A Chapter in the Calculus of Variations: Maxima and Minima, for Weak Variations, of Integrals involving Ordinary Derivatives of the Second Order. By Dr. A. R. Forsyth. Pp. 149-193. 4s. Vol. 46, Part 2, No. 16: On Triple Systems of Surfaces and Non-Orthogonal Curvilinear Coordinates. By Dr. C. E. Weatherburn. Pp. 196-205. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 13: On the Contents of Helium and other Constituents in the Natural Gases of Japan. By Yoshihiko Kano and Bunnosuke Yamaguti. Pp. 347-360+3 plates. (Tōkyō: Maruzen Kabushiki-Kaisha.) 75 sen.

Nigeria. Fourth Annual Bulletin of the Agricultural Department, 1st August 1925. Pp. 217. (Ibadan: Department of Agriculture.) 5s.

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the Year 1920. Pp. xix+148. (Cairo: Government Publications Office.) 30 P.T.

Report of the National Baby Week Council, 1925. Pp. 31. (London: 117 Piccadilly, W.1.)

United States Department of Agriculture. Department Bulletin No. 1395: Bats in relation to the Production of Guano and the Destruction of Insects. By Edward W. Nelson. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

The Rockefeller Foundation. Annual Report for 1924. Pp. xi+447+34 plates. (New York.)

Annales de l'Institut de Physique du Globe. Fascicule spécial consacré aux expériences de la courtine sur la propagation des ondes aériennes. Pp. viii+50. (Paris: Les Presses universitaires de France.)

Poradnik dla Samouków, Tom. 6. Botanika, 1. Pp. xi+713. (Warszawa: Imienia Mianowskiego.)

Department of Scientific and Industrial Research. Second Report of the Adhesives Research Committee. Pp. iii+128. (London: H.M. Stationery Office.) 3s. net.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 49. Edited by Prof. Walter Howchin; assisted by Arthur M. Lea. Pp. iii+324+24 plates. (Adelaide.) 18s.

Publications of the Washburn Observatory of the University of Wisconsin. Vol. 14, Part 2: Meridian Observations of Comparison Stars. By Albert S. Flint. Pp. 189-225. (Madison, Wis.)

The University of Chicago: Publications of the Yerkes Observatory. Vol. 4, Part 4: Zone +45° of Kapteyn's Selected Areas; Parallaxes and Proper Motions of 1041 Stars. By Oliver Justin Lee. Pp. v+67. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.)

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1925. Pp. 39+5 plates. (New York.)

Diary of Societies.

SATURDAY, MAY 8.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—L. Colledge: Mosher's Method of Skin Grafting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. P. C. Buck: The Song Form in England as represented by Parry.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Llandridod Wells).

SUNDAY, MAY 9.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Llandridod Wells).

MONDAY, MAY 10.

ROYAL IRISH ACADEMY (Dublin), at 4.15.

BIOCHEMICAL SOCIETY (in Physiological Laboratory, St. Bartholomew's Medical College), at 4.30.—Dr. C. Dorée and E. C. Barton-Wright: A Note on the Stone-cells of the Pear.—Margaret H. O'Dwyer: On the Nature of the Hemicelluloses.—H. D. Carey: The Oxides and Oxyacids of Phosphorus by a New Method of Graphic Formulæ.—Prof. C. Lovatt Evans: Conditions affecting the Formation of Lactic Acid in Plain Muscle.—L. F. Hewitt: The Optical Rotatory Power and Dispersion of Proteins.—G. W. Ellis: A Theory on the Nature of the Absorption of Oxygen by Unsaturated Compounds.—H. P. Marks: The Determination of Small Amounts of Lactic Acid.—R. L. Mackenzie Wallis: The Corpus Luteum and Cholesterol Metabolism.—D. T. Davies, F. Dickens, and E. C. Dodds: Observations on the Properties and Preparation of the Para-thyroid Hormone (Collip).—J. G. Davis, W. K. Slater, and V. Smith: A Thermal Study of a Suggested Anaerobic Mechanism.—H. A. Abramson, P. Eggleton, and M. G. Palmer: The Fate of Sodium Lactate injected intravenously.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Principal A. P. Laurie: Modern Research on the Methods of Painting Oil Pictures as illustrated by the Technique of the Fifteenth Century.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. A. T. Schofield: Religion and Science.

BRITISH PSYCHOLOGICAL SOCIETY (at London Day Training College), at 6.—F. C. Bartlett: Sublimation.

SURVEYORS' INSTITUTION, at 8.—Discussion on paper by Sir John Oakley on The Trustee Act, the University Act, the Land Charges Act, the Administration of Estates Act, and the Land Registration Act (concluded).—Discussion on paper by C. H. Bedells on The Settled Land Act, 1925.

MEDICAL SOCIETY OF LONDON, at 8.—General Meeting.—At 9.—Sir Berkeley Moynihan: Annual Oration.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Earl Cawdor: The People of the Tsangpo Gorge.

TUESDAY, MAY 11.

MANCHESTER GEOLOGICAL AND MINING SOCIETY, at 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. G. W. C. Kaye: The Acoustics of Public Buildings (Tyndall Lectures) (1).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—O. A. Merritt Hawkes: On the Massing of the Ladybird, *Hippodamia convergens* (Coleoptera), in the Yosemite Valley.—Dr. H. H. Scott: A Mycotic Disease of Batrachians.—A. S. Le Souëf: On the Habits of the Order Marsupialia.—Prof. R. T. Leiper: (*a*) Some Parasites of Rats in the Zoological Society's Gardens; (*b*) The Starling as a Factor in the Spread of Gapeworm Disease in Chickens.

INSTITUTE OF PHYSICS (at Royal College of Science), at 5.30.—H. E. Wimperis: The Relationship of Physics to Aeronautical Research (Lecture).

INSTITUTE OF MARINE ENGINEERS, at 6.30.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—E. Heron-Allen and A. Earland: Selective Building in the Shells of the Foraminifera.

WEDNESDAY, MAY 12.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology) (Annual General Meeting), at 4.30.—Prof. J. Fraser, S. Seton Pringle, G. Turner, E. Miles, and Mr. Lockhart-Mummery: Discussion on The Value of the Closed Methods in Resection of the Colon.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Informal Meeting.

ROYAL SOCIETY OF ARTS, at 8.—W. S. Bradley: Industrial Welfare in Practice.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—W. T. J. Gun: Some Aspects of Hereditary Ability.

THURSDAY, MAY 13.

FARADAY SOCIETY (at Institution of Mechanical Engineers) (Discussion on Explosive Reactions in Gaseous Media), at 2.30 and 5.—Part I. Explosive Reactions Considered Generally:—Dr. W. E. Garner: Introductory Survey.—Prof. H. B. Dixon, J. Harwood, and W. F. Higgins: On the Ignition Point of Gases.—Prof. W. T. David: Radiation in Gaseous Explosions.—Dr. S. W. Saunders and Dr. W. E. Garner: Ionisation in Gas Explosions.—Dr. S. C. Lind: Ionisation and Gas Explosions.—Prof. R. V. Wheeler and Dr. W. Payman: The Uniform Movement of Flame.—Prof. W. A. Bone: Explosions at High Pressure.—Dr. Colin Campbell and Prof. H. B. Dixon: Explosion Wave in Cyanogen Mixtures.—At 7.45.—Part II. Explosive Reactions Considered in Reference to Internal Combustion Engines:—Sir Dugald Clerk: Introductory Survey.—Prof. W. T. David: Combustion in Gas Engines.—H. T. Tizard: Explosions in Petrol Engines.

ROYAL SOCIETY, at 4.30.—Sir Arthur Schuster: A Review of Mr. George W. Walker's Magnetic Survey (1915).—Dr. A. E. H. Tutton: The Alkali Perchlorates and a New Principle concerning the Measurement of Space-Lattice Cells.—Prof. G. I. Taylor and W. S. Farren: The Distortion of Crystals of Aluminium under Compression. Part I.—Dr. E. V. Appleton, R. A. Watson Watt, and J. F. Herd: On the Nature of Atmospherics.—T. T. H. Verschoyle: Isotherms of Hydrogen, of Nitrogen, and of Hydrogen-Nitrogen Mixtures, at 0° and 20° C. up to a Pressure of 200 Atmospheres.—*To be read in title only*:—Prof. C. H. Lees: On the Determination of the Specific Heats of Gases at Constant Pressure and at Constant Volume and their Ratio by Adiabatic Expansion.—T. G. Room: A General Configuration in Space of any Number of Dimensions analogous to the Double-Six of Lines in Ordinary Space.—C. N. Hinshelwood and W. K. Hutchison: A Comparison between Unimolecular and Bimolecular Gaseous Reactions. The Thermal Decomposition of Gaseous Acetaldehyde.—P. A. M. Dirac: (*a*) The Elimination of the Nodes in Quantum Mechanics; (*b*) Relativity Quantum Mechanics with an Application to Compton Scattering.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 5.—Annual General Meeting.

INSTITUTE OF PATHOLOGY AND RESEARCH (ST. MARY'S HOSPITAL, W.2), at 5.—Dr. L. Colebrook: The Chemo-Therapy of Bacterial Infections (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Imperfect Crystallisation of Common Things (3).

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—B. Graves: Microscopy of the Living Eye.—Dr. L. C. Martin: The Distribution of Light in Elementary Optical Images.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, MAY 14.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Western District) (at Blackburn), at 10.45 A.M.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—L. Hartshorn: The Properties of Mutual Inductance Standards at Telephonic Frequencies.—Prof. A. L. Narayan and K. R. Rao: A Note on λ4722 of Bismuth and the Nature of '*raiesultimes*.'—M. C. Johnson: The Distribution of Intensity in a Positive Ray Spectral Line.—Dr. E. E. Fournier d'Albe: Demonstration.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Leslie Smith: Notes on Static Transformer Testing and Test Plant Requirements.

RAILWAY CLUB (at 65 Belgrave Road, S.W.), at 7.30.—B. M. Bazley: Some Observations on Modern Locomotive Practice.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Seton Gordon: The Golden Eagle and its Neighbours.

SATURDAY, MAY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. C. Simpson: Atmospheric Electricity (1).

PUBLIC LECTURES.

MONDAY, MAY 10.

GRESHAM COLLEGE (Basinghall Street, E.C.), at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 11, 12, and 14.)

THURSDAY, MAY 13.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Egypt.

CONGRESSES.

MAY 13 TO 15.

INSTITUTE OF TRANSPORT (at Birmingham).

MAY 22 TO JUNE 2.

ITALIAN NATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY (at Palermo).

MAY 24, ETC.

INTERNATIONAL GEOLOGICAL CONGRESS (at Madrid).

MAY 24 TO 29.

INTERNATIONAL ORNITHOLOGICAL CONGRESS (at Copenhagen).

MAY 25.

INTERNATIONAL SOCIETY FOR THE PROTECTION OF CHILDHOOD (at Rome).