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CONTENTS

History Based on Science

A POWERFUL, learned and convincing book which has just appeared will, it is to be hoped, turn the minds of many people, besides readers of NATURE, to the consideration of the subject raised in the title of this article. The book is the second volume of Prof. Preserved Smith's "History of Modern Culture",* of which the first volume was noticed in these columns on April 4, 1931 (127, 515). We shall have something further to say about it later on. The subject is the large one, still unrecognised by most thinkers in its true greatness, of the part which science has played, and is playing with increasing vigour as we write, in changing and building up the fabric of society.

It is, of course, a commonplace that the discoveries and applications of science are the leading feature of our own age. Some people deplore the effect of this development on ways of thought and life; others, like M. René Sand, more justly, point out the enormous advantages to health and happiness which have already accrued to mankind from this source, and the illimitable supply which is at our command for the future, if we have the wisdom to use it. No one disputes the fact. But the strange paradox faces us, that, though this is admitted with regard to the present, the historians, those whose business it is to show how the present has arisen from the past, scarcely pay any attention to science at all. Yet, surely, here again, we may start from two universally accepted truths; one, that the present is the child of the past and formed by it; two, that man is primarily the thinking animal, so that the history of his thought must be the most important part of his whole history. In spite of this, the vast bulk of the history still taught and written deals exclusively with politics and war. We are shown how men use and abuse their means of associating with one another. We are not shown the nature or the growth of the one thing in which their association is most perfect, and by means of which they have gained their power of controlling the external world.

Some people treat this as a purely academic question, to be settled by those who have the matter in hand. Authors, they say, must study and write about the things that interest them and their readers. If people want the interest of chemistry, they will get it, and, surely, there are plenty of histories of chemistry? One cannot,

* A History of Modern Culture. By Prof. Preserved Smith. Vol. 2: The Enlightenment, 1687–1776. Pp. vii+703. (London: George Routledge and Sons, Ltd., 1934.) 12*s*. 6*d*. net.

however, just leave the question unanswered, for there is a thing called 'history' quite apart from the special histories of chemistry, art, religion, etc., and it is this general thing, called commonly 'history', to which we are now referring. It is that which forms the staple of what is taught in schools as 'history', and of which people think, when asked, if they care about history or know much about it. This common or general thing is made up almost entirely of politics and war, and it is this which statesmen and reformers now have in mind when they set up committees "to examine the historical textbooks and eliminate obnoxious matter" (as now in London), or commission writers to produce new history books, inspired by a certain desired spirit (as now in Germany). Evidently, the men who take this executive action think that there is something to be gained by doing it, and, though they probably exaggerate the possible effects of their action, we must agree with them when they find something more in history than the mere gratification of a special interest and treat it as a matter of profound social and intellectual concern. Unfortunately, however, those thus criticising and prescribing history books only deal, as a rule, with the fringes or excrescences of the matter. They only notice the special points obnoxious to their own point of view, and the root of the whole mischief escapes them.

The best proof of the truth which we are trying to establish—and incidentally the best evidence of the mischief of missing it—is to be found in works where the authors are clearly free from such propagandist intent as we have just instanced, and seem obviously trying to present the facts as they were. It happens that a book of great learning and bulk has recently begun to appear in England and has been received with a chorus of approval by the Press. This is Prof. A. J. Toynbee's "Study of History", of which the first three volumes appeared in the autumn and several more are promised. It is in many points similar to the more famous work of Spengler, and in the matter now under discussion is open to the same criticism. The general thesis, enforced by a wealth of interesting detail, is that history should be regarded as the record of the birth, flowering and decay of a large number of independent civilisations which we may indeed group into more or less cognate families, but which have their hour and pass away like the individuals who compose them. Prof. Toynbee has in fact a special section in which he denounces the 'misconception' of the 'unity of civilisation', while Herr Spengler, as is well known, has discovered and explains the decay and disappearance of the Western civilisation around which this unity is commonly supposed to rest and to be growing.

It is, of course, largely a question of terminology whether we speak of many 'civilisations' which pass away, or of one human 'civilisation' which lasts and grows. But there is one supremely important point involved in the belief in a real unity of civilisation, whatever the temporary varieties under which civilisation may appear in China, Egypt, Mexico and the rest; and it is just this one supreme point which the authors mentioned, and many more, completely miss. The unity of civilisation does not mean the temporary unification of a large part of the earth's surface whether by an Alexander, a Roman Empire, a Genghis Khan, or the colonising armies of modern Europe. It means that the root of human civilisation is *one*, and is to be found in the development of the human mind, which is similar all over the world in its effective contacts with external Nature, and of which science—understood in the widest sense—is the most characteristic and most permanent fruit. It is because science in this sense is missed by these theorists, and the hosts of others less learned than they, that we have all this talk about passing away of civilisation, the decay of the West, the bankruptcy of man.

If we study carefully the various features of the 'civilisations', described by Prof. Toynbee and others as having 'passed away', we find that they consist mainly of forms of art, language and literature, which naturally do attain a perfection of form and then decay or are transformed into other shapes. Thus Latin literature reached perfection with Virgil and then decayed. The renascence with Dante took a new form, though even here it would be too much to say that Virgil was dead. But science differs in this respect profoundly. It is not an art-form like a Greek vase or an ode of Horace. The changes made in its expression—systems of numeration, use of cipher, indexes, equations and so forth—are not comparable to the temporary laws of metre or to styles in architecture. They are rather progressive attempts to simplify the apparatus of thought, to make the common human mind more competent in ordering its thoughts and dealing with phenomena. Greek geometry or the Hindu cypher is not a fashion. It is absorbed permanently by mankind, and, though it may be further simplified

or put into a still more general form, we all need to use it at some stage of our mental development.

This comparative illustration is surely an apt one, and may be extended with due qualifications to science as a whole, which is constantly approximating to the precision of mathematics. It is a common human possession, and a living and growing one, being in fact the best guarantee both of the unity of mankind and the future of civilisation. Clearly, therefore, on all grounds, it should take a foremost place in our apprehension of history and in our presentations of it to others. It is a difficult task, the most difficult perhaps in the whole of education; but it is scarcely too much to say that up to the present the attempts that have been made have either merely scratched the surface, or else burrowed so far below it that the work is not apparent to the mind of the average educated man. History remains for the mass that story of political and military events (largely the latter) to which we referred above. A book like that of Prof. Preserved Smith is, therefore, heartily to be welcomed, for he has the root of the matter in him. "Beginning," he tells us, "in the seventeenth century, men began to look forward and not back, to the future and not to the past, for the era of perfection. The reason for this is simply the triumph of science. By the end of the seventeenth century even the dullest could see that in knowledge of nature his contemporaries were superior to the most renowned of the ancient worthies."

Vol. 2 of Prof. Smith's work covers the years from 1687 to 1776, and is called 'The Enlightenment', implying that awakening of the European mind to its possibilities which followed the scientific revolution of the seventeenth century. True to his estimate of the relative value of the various factors in the intellectual evolution of the time, Prof. Preserved Smith devotes his first section to science, the next to philosophy, the next to history, and so on. It is a fairly complete and well-documented account of the intellectual output of nearly a hundred years preceding the French Revolution. The author's reading is enormous, his style is clear and often pointed, and his quotations always apt and often amusing. But, praise and enjoy it as we may, one cannot feel that we yet have the comprehensive and well-knit survey of history, inspired by science, which is the great desideratum. This book is rather an interesting encyclopædia of a definite and important part of modern thought, full of profound reflections connecting one section of the picture with another, but not a forward-moving account of the whole as an expression of the growth of the human soul in that period, which the ideal requires. There are so many trees in the forest, and we are so much interested in studying and comparing their shapes, that we tend to forget where it lies on the earth's surface and where it leads us. The work of clear but sound synthesis in history still remains very largely to be done, especially in England, which is in practical ways the most historical of countries.

In theoretical work of this kind we are now, as often before, outdistanced by others and perhaps most of all by the French. This synthesis, the most needed for moral and international reasons, must be based on the subordination of other aspects of history to that of the growth of thought, and it will trace this growth from the humblest beginnings with the first ape-man to the conquering intellect which now embraces the universe.

Reviews

Mathematics before the Greeks

Vorlesungen über Geschichte der antiken mathematischen Wissenschaften. Von O. Neugebauer. Band 1: *Vorgreichische Mathematik.* (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 43.) Pp. xii+212. (Berlin: Julius Springer, 1934.) 19.60 gold marks.

MUCH work has been done during recent years in the decipherment and elucidation of ancient Babylonian mathematical texts, and most of all by Dr. Neugebauer, the editor of this volume. It is not too much to say that no such treasure trove has come into the possession of historians of mathematics since the year 1906, when Heiberg discovered in a palimpsest at Constantinople the tract by Archimedes called by him the "Method", which was supposed to have been lost.

Since the publication of that work, other things have indeed come to light. One is the solution by Archimedes of the problem of inscribing a regular heptagon in a circle; another is the Moscow papyrus acquired by the Museum of Fine Arts at Moscow in 1912 and at length published by W. W. Struve in 1930. But these things have added much less to our knowledge of ancient mathematics than the series of cuneiform texts the content of which is set out in the volume before us. Dealing with Egyptian as well as Babylonian mathematics, Dr. Neugebauer justly claims that his is the first

attempt to give a comprehensive view of the history of pre-Greek mathematics, and we cannot be too grateful to him for his admirable exposition. It is intended to be followed in due time by two more volumes ; vol. 2 will deal with Greek mathematics, while vol. 3 will treat of exact astronomy and particularly the classical work of Ptolemy on one hand, and, on the other, Babylonian astronomy of a relatively late date, the facts about which are much less accessible and more difficult to appraise.

The present volume is divided into five chapters. The first is on the technique of Babylonian numerical calculation (36 pages) ; the second (41 pages) contains a general historical account of the language and writing of the cuneiform texts, the Babylonian mathematical terminology, and finally the Egyptian hieroglyphic and hieratic scripts. Chap. iii (30 pages) describes the Babylonian and Egyptian numeral systems, the notation for whole numbers and fractions, and lastly the sexagesimal system of arithmetical notation and its development as a 'position-value' system of the most thoroughgoing kind. Chap. iv (56 pages) gives a general and complete account of Egyptian mathematics, the geometry of areas and volumes, arithmetic including fractions and their manipulation, and problems equivalent to elementary algebraical equations. Chap. v (42 pages) describes at length the whole content of Babylonian mathematics as it now appears in the light of all the texts so far investigated. The headings include geometry, arithmetic and algebra. Algebra includes linear equations with a number of unknowns, quadratics with one or two unknowns, and some cubic equations ; there are also some problems in simple and compound interest.

Babylonian geometry is mostly the mensuration of areas and volumes (π is taken as 3, not such a good value as the Egyptian approximation) ; but calculations of the 'sagitta' of a chord of a circle by means of the lengths of the diameter and the chord, and the converse, involve the use of the Pythagorean theorem of the square of the hypotenuse. The Babylonian arithmetic and algebra are far more remarkable, for the dates (about 2000 B.C.) to which the texts belong. In arithmetic the sexagesimal scale is consistently used instead of the decimal ; each number (up to 59) corresponding to our 'digit' means some power of 60 ; numbers are expressed as the sum of descending powers of sixty followed by units and then by successive sexagesimal fractions ; 'position-value' is fully secured by the existence of a sign, corresponding to our 0, to indicate the absence of a particular denomination. The Babylonians did not even trouble to specify any denominations ; they left them to be inferred from the context ; thus 30 may anywhere mean $\frac{1}{2}$ as easily as 30 units, and so on. To divide one number a by another number b, they took the reciprocal of b $(1/b)$, expressed it as a sum of successive sexagesimal fractions, and multiplied a by $1/b$. For this purpose they had tables of reciprocals, just as they had multiplication tables ; the reciprocal of 1 21 (81 in our notation) is given as 44 26 40, which means in this case 0 44 26 40 (there being no units in the expression but only sexagesimal fractions) ; the product of 1 21 and 0 44 26 40 will be found to be 1.

The Babylonians solved quadratics without stating any general formula ; but they calculated the root in concrete figures precisely in accordance with the formula as given in our textbooks ; the unknown quantities are not called x, y, z (or by any equivalent symbol), but they are the 'length', 'breadth', 'depth', etc., respectively in some geometrical figure. Problems leading to some cubic equations constitute somewhat of a puzzle. Some produce an equation of the form $x^3 + x^2 = a$; and the key to the solution in this case was discovered by Neugebauer in certain tables of numbers of the form $n^3 + n^2$. Other cases are not yet explained, and it may be that the root was known beforehand and the problem framed accordingly. There are some approximations to the square roots of non-square numbers ; one uses the approximation $a + (b/2a)$ for $\sqrt{(a^2 + b)}$, which is common in Greek mathematics. In view of the Babylonians' proficiency in algebra about 2000–1800 B.C., it is extraordinary that no *arithmetical* solutions of quadratic equations (as distinct from geometrical solutions) are found in Greek writers before Heron and Diophantus.

In the account of Egyptian mathematics (chap. iv), there is not much that is new in substance, but the exposition is succinct and comprehensive, and new points of view frequently emerge, especially with regard to the dexterous way in which the Egyptians manipulated their fractions, which (except for $\frac{2}{3}$ and occasionally $\frac{3}{4}$) were confined to submultiples and sums of such. There is a useful discussion of problems 14 and 10 of the Moscow Papyrus, the first of which uses the correct formula for the volume of a frustum of a pyramid with square base, while the second purports to give the superficial area of a certain curved surface. It is interesting to note that Dr. Neugebauer inclines to Peet's interpretation of the language of the latter problem, which makes the surface measured to be a half-cylinder and not a hemisphere as supposed by Struve.

As a matter of printing, the volume is beautifully produced ; altogether, it is a fine piece of work, and cannot be too strongly commended. T. L. H.

Animal Behaviour

The Behaviour of Animals: an Introduction to its Study. By Dr. E. S. Russell. Pp. viii+184+6 plates. (London: Edward Arnold and Co., 1934.) 10*s.* 6*d.* net.

THIS small book is a model of its kind, providing, as it does, an excellent summary of the existing knowledge of animal behaviour, and being full of suggestions with regard to further profitable experimentation. But it is more than a pleasantly written résumé, compiled by a man who obviously knows his subject and is intrigued by the many problems in this field which seem to defy human understanding. It is a challenge to zoologists.

With very few exceptions, animal behaviour is a study sadly neglected by professional zoologists in Great Britain; so neglected that its territory has been claimed by the physiologist and psychologist. In this fact danger lurks, for, as Dr. Russell argues, quite commonly the proper place for the study of animal behaviour is not the laboratory, and since the physiologist and psychologist are not necessarily naturalists, as the zoologist must needs be, the manner in which an animal lives and maintains itself in Nature has been almost completely disregarded.

Dr. Russell is perfectly justified in his view that shepherds, fishermen, fanciers and sportsmen have much of importance to tell the biologist, for those of us who know these men and have captured their interest are greatly indebted to them. They have vast stores of accurate information which, properly examined, and freed from anecdote and conjecture, can be made to reveal matters of profound scientific value. It is true that their interpretations may not, and usually do not, coincide with our own, but the extent of their knowledge of the habits of the commoner beasts and birds is astonishing. They may know nothing of mechanisms, but they do know a great deal of the animal as a whole. Thus it is that Dr. Russell finds himself happy in their company, for he strenuously revolts against the purely mechanistic view and pleads for a return to the Aristotelian approach, according to which life and mind are regarded as continuous one with the other, the basis of the zoological system being the form and the behaviour of the animal as a single entity.

The author strongly emphasises the value to science of recording as fully as possible the normal everyday activities of animals, especially in the wild; of describing the objective facts in the simplest and most comprehensive way, disregarding all speculation about the animal's inner life, and studying only the overt and visible actions. Dr. Russell teaches that behaviour is always directed toward some definite end, and is largely determined by its result, the action continuing until the goal is reached; that behaviour is often active or spontaneous in the sense that it is not a reaction to external stimuli, and that animals perceive an external world of their own. Thus, in studying animal behaviour, the first question to be asked is: What is the animal trying to do? The second: To what exactly does it respond, that is to say, what does it perceive? The third: How does its behaviour develop through maturation and through experience? Finally: Is the animal's behaviour modifiable or adaptable?

The book considers these matters in some detail and illustrates the methods of simple, direct observation without theory and without analysis. It leaves all questions on mind and matter to the philosophers. It is addressed to students of biology and to the general public, and to these it can be strongly recommended. Reading this book, one is driven to the conclusion that no zoological curriculum can be regarded as being complete unless it includes a course of animal behaviour given by someone with Dr. Russell's knowledge and devotion to his subject.

Embryology and Genetics

Embryology and Genetics. By Prof. T. H. Morgan. Pp. viii+258. (New York: Columbia University Press; London: Oxford University Press, 1934.) 15*s.* net.

ONE of the most serious gaps in the whole structure of theoretical biology is the lack of connexion between the concepts of genetics and of embryology. Both sciences have a peculiar importance for biology because they both deal with their subject matter in a particularly objective way. The organism is not analysed along any of the lines worked out by the older physical sciences, but the path of analysis grows directly out of the reactions which are observed. In this respect, genetics has been conspicuously successful, so that we can now, theoretically at least, represent an organism symbolically as a set of genes. In practice, we cannot give a completely sufficient representation of an organism in this way, but we can often state precisely the way in which it differs from its fairly near relatives. It is as though we knew the active groups of a complex organic molecule, but not the molecular nucleus.

In genetics, one gene stands symbolically for a whole series of developmental stages, so that it may be said to determine a red eye at one stage, for example, and a black eye at another, like some of the genes discovered by Huxley and Ford in

Gammarus. It should be the province of embryology to lay bare the basis of such series and to find how genes interact to produce their final effects. This involves an analysis of the whole process by which a complicated adult organism is developed out of an apparently simple egg-cell, and has been found to be an extremely difficult task. As yet, experimental embryology has been chiefly concerned with the blocking in of the main features of the future organism, and has found itself dealing with characters which are not much affected by the genes described by geneticists, characters in fact which, to pursue the analogy mentioned above, seem to depend on the molecular nucleus in the formula for the organism.

There could be no one more fitted to explain the importance of these matters than Prof. Morgan, who is at once a well-known experimental embryologist and the foremost geneticist of his time. His book should appeal to a wide public, since although not entirely popular, it is written in a way which makes it comprehensible to scientific workers who have not previously taken particular interest in the questions under discussion. A general reader will find here one of the most lucid summaries of experimental embryological research into such questions as the development of isolated blastomeres or egg fragments, or the artificial production of twins. The results of these inquiries cannot easily be summarised, and an account of them therefore occupies more space than need be devoted to the clear-cut results of genetical experiments, which have led to a very few generally applicable hypotheses.

The confused mass of data obtained by the older experimental embryology is at last beginning to be put in order under the influence of the recent work of Spemann, who registered the first success in the attack on the fundamental problem of embryology. This problem is, I take it, the question of why a given part of the embryo develops into a given part of the adult, and Spemann's answer, that it does so because it is stimulated to do so by an organiser, is only the first crude beginning of the analysis, comparable to saying that a muscle contracts because it is stimulated to do so by a nerve. But crude though it may be, it is the best we can do as yet. The importance of having any answer at all, even if we have some doubts as to how widely it can be applied, is so great that it is primarily in connexion with these theories that we shall have to examine the relevance of the ideas of genetics.

Prof. Morgan, by a self-denying ordinance, rigidly denies himself all speculation on this subject, but indications are not lacking that it will soon be possible to attack the problem. Already there is the significant fact that when an organiser induces an organ, the reacting tissue develops its own peculiar specific characters. Seidel's demonstration that the activity of the *Bildungszentrum* in the insect egg depends on the interaction of the nuclei and the cytoplasm is another hint. We already know something about the action of genes which affect some of the better understood biochemical systems, such as the system which leads to the formation of pigment in some animals. It is probably not too much to hope that our knowledge of the chemistry of organiser action will soon develop to a similar level. But as yet we have no idea how to explain the action of genes which determine pattern. Some aspects of this, the most difficult problem of morphology, are considered fairly fully by Morgan, who gives us two chapters on the production of two embryos from one egg, or one embryo from two eggs. These two chapters, like the rest of the book, raise in a most fascinating way a series of important problems, at the answers to which Prof. Morgan is too cautious to guess in our present state of ignorance.

C. H. WADDINGTON.

Photo-electric Cells and their Applications

Photoelectric Cells: their Properties, Use and Applications. By Norman Robert Campbell and Dorothy Ritchie. Third edition. Pp. vii+223. (London: Sir Isaac Pitman and Sons, Ltd., 1934.) 12*s*. 6*d*. net.

THE third edition of this book is, as its authors point out, practically a new book altogether, though certain portions of the previous editions are retained without much alteration. The differences arise not so much from the new material which has become available since the last edition was issued—though this is considerable—as from a change in the balance of the treatment, and in the class of reader for which the book is intended. It is now less of a handbook for those who actually want to use photo-cells, or a textbook on the theory of the photo-electric effect, than a book for those who might want to use them, and do not object to a somewhat abstract method of treatment.

This edition is divided into three sections, dealing respectively with the properties, methods of use, and some of the applications, of photo-cells. The first section is that which differs most from the last edition. It starts with a moderately full, though not mathematical, account of the theory of the internal and external photo-electric effects and of rectification at thin films, based on the idea of stationary states for the 'free' electrons in metals and semi-conductors. This is followed by full and clear accounts of the properties of vacuum

and gas-filled emission cells, of rectifier and of conductivity cells. These are accompanied by a large amount of illustrative data given in the form of diagrams.

The next section deals in a moderately detailed way with the manner of using photo-cells. It starts with an abstract account of the principles of measuring instruments with special reference to photo-cells. This is followed by two chapters on the measurement of the small currents which arise when the photo-cells are used with light of low intensity, and with valve amplification of the output from a photo-cell. The modern four-electrode electrometer valve has replaced the valve bridges previously described, and mention is made of the use of the galvanometer in ballistic fashion. The final chapter deals mainly with 'ticker' methods of measuring the current.

The final section is called "Some Applications of Photoelectric Cells", and is the least satisfactory part of the book in that it gives the impression of being merely the summary of a much more extensive treatment of the various branches of photometry by means of photo-cells. (May we hope for such a treatment as a separate book in the near future?) It gives, however, a useful comparison of many ways of using these cells for the measurement of light intensities.

The book is not quite free from misprints and slips of the pen, but these are few. The printing and paper are an improvement on those of the last edition.

Short Notices

Die Dreielektrodenröhre und ihre Anwendung: Übungen an der Dreielektrodenröhre mit den zugehörigen theoretischen Erläuterungen. Von Dr. Friedrich Moeller. (Abhandlungen zur Didaktik und Philosophie der Naturwissenschaft, Heft 15.) Pp. vii+155. (Berlin: Julius Springer, 1934.) 9.60 gold marks.

DR. MOELLER'S book is designed for students, and it is a recommendation that it deals with the subject from both the theoretical and practical points of view. The object of the author is set out in his foreword: ". . . the theoretical portion of the book can be looked upon as a text-book of the electron-valve, which attempts to explain the simpler problems of valve-theory without the necessity for special prior knowledge of A.C. technique".

The subject matter is divided into five main parts, and these are subdivided into 'Theory' and 'Practical'. The parts deal with (1) the valve itself, and its properties, giving the definitions of 'slope', *Durchgriff*, etc.; (2) triodes with resistance anode loads—amplification and power output; (3) triodes with tuned circuits, including H.F. amplification and self-oscillation; (4) modulation; and (5) demodulation.

It is felt that the author has undertaken a very difficult task in attempting to cover satisfactorily the theory of all this ground even to the extent required for a textbook of the triode for students, in a book of 150 pages; and when, in addition, space is allotted to practical experiments, some omissions are inevitable. Thus, although the book does cover a large part of the ground in a very thorough way (often, we feel, too thoroughly), a number of important problems are omitted or dealt with very briefly, and one is often left with a feeling of incompleteness. The practical considerations are not always dealt with in the best way, and often digress into further theory.

Nevertheless, judged by the amount of information that has been included, the omission of advanced mathematics, and the suggestions for practical confirmation of results, the book should form a very useful addition to the series of scientific textbooks of which it forms the fifteenth volume, and should provide a good starting point for a radio student.

The phraseology of the book is moderately straightforward, and anyone with a fair knowledge of the German language should have little difficulty in reading it, though the reasoning often seems unnecessarily involved, and the methods rather cumbersome. Its value as a textbook and more so as a reference book would be improved by the addition of bibliographical references, there being at present only some half-dozen, and these to other volumes of the same series.

Handbuch der Biochemie des Menschen und der Tiere. Herausgegeben von Prof. Dr. Carl Oppenheimer. Zweite Auflage. Ergänzungswerk, Band 2. Pp. xix+961. (Jena: Gustav Fischer, 1934.) 71 gold marks.

IN a review of the last published supplementary volume to this work—1154 pages, in two half volumes, bringing vols. 1, 2 and 3 of the second edition of the "Handbuch" up to the end of 1932—it was stated (NATURE, **133**, 595; 1934) that the volumes were of the type that filled "the user with awe-inspired gratitude and the reviewer with awe-inspired terror". A similar effect is produced by the second supplementary volume; it brings the main vols. 4, 5 and 6 up to, presumably, the same date; it occupies, with its index, nearly 1000 pages; and it is apparently just within the 'single volume' limit.

This makes it somewhat unwieldy, as well as somewhat unviable in the unbound form. Still, the names of some of the contributors, Profs. L. Pincussen, J. Wohlgemuth, W. Grimmer, A. Scheunert, E. Grafe—to select at random a few, none of whom contributed to the first supplementary volume—will almost certainly secure that the possessors of paper-bound copies hasten to get a volume of such obvious value put into boards as quickly as possible.

The contents of this supplementary volume are divided in the following manner. The supplement to vol. 4 is concerned with the chemistry of tissues and organs, including blood and lymph, skeletal and epidermal structures, muscle, the apparatus of circulation and respiration, the nerves and sense organs, and the chemistry of tumours. The supplement to vol. 5 deals with the glands and secretory organs, which are classified into those involved in digestion and those involved in reproduction. The supplement to vol. 6 covers the general field of nutritional processes, including digestion, absorption and excretion. Finally, vol. 7 is brought up to date under the subheadings of nutrition, gas exchange and general metabolism.

It is clearly impossible to do more than indicate here in a quite general way the field surveyed in this book; the largeness of the field is in itself a measure of the vastness of territory mapped in the original work to which this is the second supplementary volume. A. L. B.

Radio round the World. By A. W. Haslett. Pp. vii+196+7 plates. (Cambridge: At the University Press, 1934.) 5*s.* net.

THIS volume presents an interesting account, in a form suitable for the layman, of the main facts accompanying the application of electric waves to radio communication. A brief, historical account of the earliest discoveries of these waves includes a reference to the doubts and difficulties which accompanied the pioneer workers of some thirty years ago. The story of the propagation of electric waves of all lengths round the world, by the aid of the ionised layers in the earth's atmosphere, is then developed in a straightforward and skilful manner. A chapter entitled "The Sun calls the Tune" is noteworthy in this portion of the book, and directs attention to the various ways in which the possibilities of long-distance radio communication are controlled or limited by solar influence.

Later chapters utilise an account of the trend of modern developments to indicate the future possibilities of radio technique, particularly in the application of ultra-short waves to secret communication for war purposes, to television, and, by no means least important, to the introduction of a new phase of curative medicine.

On the whole, the author has obviously taken a good deal of trouble to get his facts correctly stated, although p. 160 contains, in a loosely worded sentence, a bad misrepresentation of the possibilities of radio direction finding. A reviewer in another country might complain that in certain portions of the book undue stress is placed upon recent British work in radio research; while in other places, the author has omitted to mention the Radio Research Board, from the publications of which so much of the material has obviously been derived. These are, however, minor blemishes in an otherwise successful effort to show the general reader how very much more there is in the science and practice of radio communication than the mere dissemination of broadcast programmes.

Annales Bryologici: a Year-Book devoted to the Study of Mosses and Hepatics. Edited by Fr. Verdoorn. Supplementary Vol. 4: *Studien über Asiatische Jubuleae (de Frullaniaceis 15–17) mit einer Einleitung: Bryologie und Hepaticologie, ihre Methodik und Zukunft.* Von Fr. Verdoorn. Pp. viii+231. (The Hague: Martinus Nijhoff, 1934.) 6 guilders.

A SKETCH of the progress of hepaticology occupies the first thirty-six pages; a knowledge of early authors is considered essential in questions of nomenclature and in dealing with types of genera; Evans, Howe, Lindberg, Schiffner and Spruce are authors favourably mentioned, but Stephani's "Species Hepaticarum" is very frankly criticised; its errors and other faults are considered to be so grave, that setting it aside as "opus excludendum" is discussed; in view however of its wide acceptance, that course is inexpedient and revision is recommended. Improved methods, geographical, cytological, genetical, experimental morphological, etc., are urged in the study of liverworts; the weakness of much recent bryological literature is referred to. Revision is the most urgent need of to-day; progress will largely depend on the study of the smaller groups, which are insufficiently understood.

De Frullaniaceis xv–xvii (pp. 40–224) carries on work published in earlier supplements. Dealing with the Lejeuneaceae, original diagnoses are reproduced as being often inaccessible to workers in Asia; there is a clavis to the fourteen genera, with notes on variability distinguishing characters, distribution and stations. Section xvi is a revision of the Asiatic Tamariscineae; a restricted but definite specific value is given to the Ocelli and a clavis to the six Asiatic species relies upon characters of the lobi, amphigastria and ocelli. Section xvii deals with some recent collections and the distribution of Indomalayan Frullaniaceae and Holostipae.

Strahlung und Lichterythem. Von K. W. Hausser und seinen Mitarbeiten. Herausgegeben von C. Ramsauer und R. Kollath. (Ostwald's Klassiker der exakten Wissenschaften, begründet von Wilhelm Ostwald, neu herausgegeben von Wolfgang Ostwald, Nr. 239.) Pp. iv+89. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1934.) 4 gold marks.

THOSE who knew the late Dr. Hausser will find much pleasure in the fact that the memory of this brilliant young physicist, who died in 1933 at forty-six years of age, is honoured by the publication of his original papers on the action of sunlight on the human skin as one of "Ostwald's Klassiker". Hausser was a pioneer in this branch of biophysics, for he was the first to realise the importance of using monochromatic light of measured intensity in the investigation of the causes of erythema and sunburn, by means of his large quartz prisms. He was responsible for the discovery of the fact that the human skin is particularly sensitive to two regions of the violet portion of the spectrum, one of which is normally absorbed by the atmosphere. All interested in biophysics would do well to possess this little book.

Radioactivity: Old and New*

By the RIGHT HON. LORD RUTHERFORD, O.M., F.R.S.

I WAS much honoured by the invitation to give the first course of the Joly Memorial Lectures. As is well known, Joly was for many years not only intensely interested in the problems of radioactivity, but also made numerous original and important contributions to our knowledge of this subject. When the large and continuous emission of heat from the radioactive bodies was made clear in 1903, Joly's alert and original mind was at once attracted to the problem of the effect of this steady generation of heat by the radioactive bodies present in the earth's crust on the geological history of our planet. To obtain reliable data, he devised simple but ingenious methods for measuring the amount of the primary radioactive bodies, uranium and thorium, in typical rocks constituting the earth's crust. He was the first to point out the far-reaching significance of this small but steady supply of heat on the internal temperature gradient of the earth, resulting in violent movements in the earth's crust. Indeed, he was of opinion that the rise and fall of continents and the elevation of mountain chains were intimately connected with the heating effect of radioactive bodies over long intervals of time. A fascinating account of these bold and original ideas has been given by Joly in his books and papers.

Of all the contributions made by Joly in the field of radioactivity, the discovery of the origin of the pleochroic haloes, observed in certain kinds of mica, has left the strongest impression on my mind. It required not only an acute and original mind but also a touch of real genius to connect these minute haloes, the origin of which had long been a mystery, with the effects of radioactive transformations. Joly, as the result of an intensive investigation, was able to prove that the darkening of the mica halo was due to the α-particles liberated over ages from a minute inclusion containing either uranium or thorium. In a well-developed halo, a series of rings was observed, each of which corresponded in radius to the range of one of the groups of α-particles liberated from the radioactive material. In this way, he was able to show that the processes of radioactive transformation were the same hundreds of millions of years ago as to-day. In some very old micas, Joly observed an inner ring corresponding to α-particles of much shorter range than any observed from the known radioactive bodies. To account for it he postulated the earlier existence of an unknown radioactive element which he provisionally named 'hibernium'. The researches of Hevesy in the last few years indicate that this ring is probably due to a known element, samarium, which has recently been found to be weakly radioactive. These haloes are produced by an exceedingly minute quantity of uranium or thorium as in inclusion in the mica. Probably the emission on an average of one α-particle every one hundred years continuing through geologic ages would give rise to a discernible halo.

I could give many more illustrations from other fields of inquiry which equally show that Joly possessed to a marked degree that rare quality of originality and vision characteristic of the greatest investigators of the past.

The property of spontaneous radioactivity is shown to the most marked extent by the heaviest elements, uranium and thorium, and the products which arise from their transformation. Only a few lighter elements show this property and those only to a feeble degree. We now know that the property of radioactivity is a sign of the instability of the atoms concerned. Take, for example, the best known radioactive element, radium. For some unknown reason, each second a minute fraction of the radium atom becomes unstable and breaks up with explosive violence, a fragment of the atom—an α-particle—being hurled out with high speed. As a consequence of these atomic transformations, a new type of atom is formed—the radium emanation—which in turn is unstable, breaking up rapidly with the liberation of an α-particle. The process of transformation once started proceeds through a number of successive stages, finally ending in the formation of a stable and non-radioactive isotope of lead. The successive transformations of uranium lead to the formation of twelve distinct types of radioactive element, and in all more than thirty of these radioactive elements are known. Each of these elements suffers transformation according to a definite law but at a different and characteristic rate. For example, radium is half transformed in 1600 years, the radium emanation in 3·82 days, and its succeeding product radium A in 3 minutes.

In most of the transformations, α-particles are alone expelled, but in a few cases the transformation is accompanied by the expulsion of β-rays, which are swift electrons. The mass of the atom is not sensibly changed by the expulsion of such a light particle, but the properties of the resulting atom are entirely changed. There is one important feature which distinguishes β-ray from α-ray transformations; all the α-particles escape with

* From the first Joly Memorial Lecture delivered at Trinity College, Dublin, on January 23, 1935.

identical speed and thus the transformation of each atom leads to the liberation of an equal quantity of energy. In the case of a β-ray transformation, one β-particle is expelled per atom, but the speed of the β-particle varies widely from atom to atom. If this be the case, one atom loses more energy than another, and we should consequently expect the energy content of the new atoms formed to differ. There is, however, no evidence that such differences of energy exist, and indeed when an α-ray body is formed by a β-ray transformation, the α-particles are again expelled with identical speeds. This difference between α- and β-transformations raises great difficulties and no satisfactory explanation is as yet forthcoming. It has been suggested either that the conservation of energy cannot be applied to such β-transformations, or that some of the energy from the atom is carried off in the form of an undetectable particle of very light mass called the 'neutrino'. We shall see that the same problem arises in the transformation of radioactive bodies which can be produced by artificial methods.

It is desirable at this stage to say a word about the nuclear structure of atoms. At the centre of each atom is a minute but massive nucleus which carries a resultant positive charge. This charge controls the number and arrangement of the electrons which surround the nucleus. The properties of an atom are thus defined by a whole number which represents the number of units of charge carried by the nucleus. This fixes the number and order of the elements, but we now know that there are many species of the same element, defined by its nuclear charge, which have different masses. The number of these isotopes of an element varies; some elements like aluminium are apparently simple, but others like tin have a dozen isotopes varying in mass over a wide range.

The appearance of radioactivity results from the spontaneous transformation of the minute nucleus of an atom. The expulsion of an α-particle carrying two positive charges lowers the charge on the nucleus of the residual atom by two units, while the expulsion of a β-particle raises it by one.

If we are to effect the transformation of an element, we must in some way alter its mass or its charge. This can be done by adding or subtracting a particle, whether charged or uncharged, from the nucleus. This is easy in imagination but difficult in practice. The most effective way so far found is the bombardment method, involving the entry of a foreign particle into the structure of the nucleus and in some cases leading to the loss of a charged particle from the nucleus. We shall illustrate these different types of transformation by considering a few of the simpler typical cases.

The first proof of the artificial transformation of an atom was given in 1919, when it was found that the bombardment of the gas nitrogen by fast α-particles gave rise to the liberation of a number of fast protons which could only come from a disintegration of the nitrogen nucleus. It is now clear that about one α-particle in 100,000 comes close enough to a nitrogen nucleus to enter its structure. The α-particle is captured and momentarily forms a new nucleus of charge 2 units higher and of mass 4 units greater. This newly formed nucleus is unstable and breaks up with explosive violence, expelling a proton in the process. The mechanism of the reaction is given below:

$$_7N^{14} + _2He^4 \longrightarrow _9F^{18} \longrightarrow _8O^{17} + _1H^1.$$

The resulting stable nucleus is an isotope of oxygen of mass 17, which we now know to exist in small quantity in ordinary oxygen. About twelve light elements can be disintegrated by α-particles, and in all cases protons of characteristic speeds are emitted; the general mechanism of the reaction is probably similar, leading in all cases to the emission of a proton and the formation of a new but stable nucleus of mass 3 units greater.

During the last few years, another important type of transformation has been brought to light in which a new and strange type of particle called the neutron is expelled. The neutron, as its name implies, carries no electric charge, but has a mass about equal to that of the proton. Since it has no charge, it does not ionise the gas in its path and consequently shows no track in an expansion chamber. At rare intervals in its passage through a gas, it hits the nucleus of an atom in its path and shoots it forward with high speed. This struck nucleus is charged and ionises the gas, so that its track through the gas is shown in a cloud chamber. While these 'knock-ons' are comparatively rare, they form a very convenient method of detecting the presence of the invisible neutron and forming an idea of its velocity. One of the best ways of producing a supply of neutrons is to bombard the element beryllium with fast α-particles. The α-particle is captured and the resulting nucleus of carbon 13 breaks up into a carbon nucleus of mass 12, while a fast neutron is expelled. The mode of the reaction is shown below:

$$_4Be^9 + _2He^4 \longrightarrow _6C^{13} \longrightarrow _6C^{12} + \text{neutron}^1.$$

We are now able to produce neutrons in a variety of ways, not only by the action of α-particles, but also by bombarding different elements by protons and deuterons.

Still another striking type of transformation can be produced by α-particles, resulting in the artificial production of new radioactive bodies. In the transformations previously considered, the

residual nucleus is a known type of stable nucleus, and is non-radioactive. A radioactive nucleus is an unstable type of nucleus which breaks up with the emission of fast particles, ultimately forming another stable nucleus. The production of an artificial radioactive body was first noted by M. and Mme. Curie-Joliot by bombarding boron with fast α-particles. After bombardment for a few minutes, the boron continued to show a marked activity for an hour or so after it was removed from the bombarding source. This activity decayed in exactly the same way and according to the same laws as the ordinary well-known radioactive bodies, but the type of particle emitted was quite different. Strange to say, it was found that high-speed positive electrons, or positrons, were emitted, and not α-particles or negative electrons such as appear in the spontaneous transformations of the radioactive bodies uranium and thorium. In order to account for the production of a radioactive element by bombarding boron with fast α-particles, it seems clear that the transformation occurs in two stages according to the scheme below :

$$_5B^{10} + _2He^4 \longrightarrow _7N^{13} + \text{neutron}^1$$
$$_7N^{13} \longrightarrow _6C^{13} + _1\text{positron}.$$

In the first stage, the α-particle is captured by the boron nucleus forming an unstable isotope of nitrogen, N^{13}, together with the liberation of a fast neutron. This isotope of nitrogen does not exist in Nature and is transformed slowly into the stable isotope of C^{13} by the expulsion of a positive electron. The activity of the radioactive body N^{13} decays to half value in about 14 minutes. By using the activity of this body as an indicator of its presence, it was shown by chemical methods that the radioactive body was an isotope of nitrogen. In a similar way, by bombarding other elements, radioactive isotopes of phosphorus and silicon could be formed, each with a characteristic period of decay.

This new discovery was rapidly followed up in a number of directions. Prof. E. Fermi and his collaborators in Rome found that a large number of these radioactive bodies could be formed when the elements were bombarded by neutrons derived from the action of α-rays on beryllium. On account of the absence of charge, the neutron is able to enter the structure of even a heavy element, where the α-particle on account of its charge is ineffective. Even the heaviest element, uranium, when bombarded by neutrons, gives rise to at least four new distinctive types of radioactive bodies, with half periods of 15 seconds, 40 seconds, 13 minutes and 100 minutes. The actual nature of the transformations involved has only been studied in a few cases. In all known cases, the neutron is captured ; sometimes a heavy particle, an α-particle or proton, is emitted, but generally a higher isotope of the element is formed which may be unstable and emit negative electrons. It is worthy of note that all the radioactive bodies produced in this way break up with the liberation of fast negative electrons and not positive electrons, as in the original cases found by the Joliots. Cockcroft, Lawrence and others have found that bombardment of certain elements by fast hydrogen ions also gives rise in some cases to the production of new radioactive bodies.

It seems clear from these results that we are able greatly to increase our knowledge of the isotopes of the elements. None of these radioactive bodies are found in Nature, but represent unstable types of isotopes with a very limited life. During the last few months, it has been found that the efficiency of the process can be increased in some cases about a hundred times or more by slowing down the neutrons. This can be done by passing them through hydrogen or a solid material like water or paraffin which contains hydrogen.

We have so far spoken of the transformations brought about by the swift α-particles spontaneously expelled from radioactive substances, and the neutrons which arise from the bombardment of certain elements by α-particles. Another notable advance has been made by the use of bombarding particles produced artificially in the electric discharge and speeded up by appropriate methods. This involves complicated apparatus and in general the use of high potentials of the order of one million volts. In this way, copious streams of fast particles can readily be produced, corresponding in number to the α-particles expelled from thousands of grams of radium. Cockcroft and Walton were the first to show that transformation effects on a comparatively large scale could be produced by bombarding light elements like lithium and boron by fast protons. Time does not allow me to consider the mechanism of these transformations, which are different for each isotope of the same element. Transformation only appears to occur when the proton is captured by the nucleus, which then breaks up with explosive violence. Similar but different effects are observed when the ions of heavy hydrogen of mass 2 are used as bombarding particles. I would like, however, to refer to recent experiments in which it has been shown that artificial radioactive elements can also be produced by these new methods. Cockcroft and Walton and others have shown that ordinary carbon, whether bombarded by H^1 or H^2 particles, gives rise to the production of a new radioactive substance which decays to half value in about 11 minutes, emitting positive electrons in the process. It is believed that the

radioactive body formed in both cases is N^{13}, which is transformed into the isotope of carbon C^{13} by the emission of a positron. It is not yet settled whether this radio-nitrogen differs from that formed by α-rays, where the half period seems to be longer, namely, 14 minutes.

It seems likely that when very intense streams of still swifter particles are available, radioactive bodies of strong intensity may be produced by these artificial methods. It may be also that some of the bodies produced in these ways may give rise to a succession of changes such as is characteristic of the heavier elements uranium and thorium.

Sufficient, I think, has been said to illustrate the extraordinarily interesting results obtained in this fascinating field of inquiry. We can build heavier elements from lighter, and break up other atoms into fragments, and produce novel radioactive elements by the score. This new field of what may be called nuclear chemistry is opening up with great rapidity. Much work, often of a difficult technical character, will be required to prove the exact nature of any of the transformations which have been observed, but a very promising beginning has been made. Future work may disclose many surprises, for new and unsuspected particles may come to light. In any event, we are entering a no man's land with the ultimate hope of throwing light on the way atoms are built up from simpler particles.

A New "Nomenclator Zoologicus"

FROM the time that the tenth edition (1758) of the "Systema Naturæ" of Linnæus, which established the binomial system, was recognised as the basis of the nomenclature of animals, systematists have always had to face the difficulty of ascertaining what names have been used for genera. Since the same name cannot be validly used more than once in the whole of zoology, it is obvious that unless this information is reasonably accessible, many homonyms are inevitably created and themselves add to the confusion. Moreover, even when the existence of a name is known, it is often by no means an easy matter to find the original reference to it or to ascertain its position in the animal kingdom. Before describing the situation at the present day, it may be as well briefly to review the attempts that have been made to solve these problems.

The first Nomenclator to be published was that of Agassiz, which appeared between 1842 and 1846; it was followed by that of Marschall, which covered the period 1846–68 and was published in 1873. In 1864 there appeared the first volume of the "Zoological Record" which, however, in its earlier years, did not always include an annual list of new genera. The names in all these, with many others, were collected together by Scudder, who attempted a list of all published genera from Linnæus to 1879, and his work, which was published in 1882–84 as Bulletin No. 19 of the U.S. National Museum, is the only list of its kind that has yet been completed. It contains about 80,000 names. Supplements to Scudder's work are represented by the two volumes, edited by Waterhouse and published by the Zoological Society of London, of the new genera contained in the "Zoological Record" with some additions. These volumes together contain some 62,000 names, and cover the periods 1880–1900 and 1901–10 respectively. The new generic names in the "Zoological Record", which average about 2,000 per annum, have not been collected together since that date.

Sherborn's famous "Index Animalium", which was published between 1902 and 1933 and deals with both generic and specific names, though marvellously complete, only goes up to the year 1850. There also began to be published in 1926, under the auspices of the Prussian Academy of Science, an ambitious work entitled "Nomenclator animalium generum et subgenerum". If circumstances had permitted this to be carried through as originally planned, it would have been a very important contribution to the problem for the period that it dealt with. Though it appears to cover the ground with relatively few omissions up to about 1909 and it purports to include all names up to 1922, those dealing with the later years are taken almost entirely from the annual indexes to the "Zoological Record". The choice of the date 1922 was peculiarly unfortunate, because the "Zoological Record" was necessarily far from complete in the War years and those immediately following, with the result that it omits the very numerous names that were actually published during 1914–22 but were only found and recorded afterwards. Furthermore, only about three quarters of this German work have yet appeared, although it has been nine years in course of publication. Its use is therefore very limited, and it has the added disadvantage of being extremely expensive.

The present position is, therefore, that a systematist who wishes to erect a new generic name finds it almost impossible, even at the expense of much labour, to satisfy himself that any given one has not been used already. Not only are his sources of information very scattered and far from complete, but also many of them are rare and expensive.

The Council of the Zoological Society of London has therefore decided to make financial provision for a scheme to produce an entirely new "Nomenclator", in which an attempt will be made to include every generic name used in zoology from 1758 up to and including 1935. It is estimated that this will involve about 190,000 names, of which about 100,000 relate to insects. The names from 1758 to 1879 will be given their original references, these being taken, so far as those up to 1850 are concerned, from Sherborn. From 1880 onwards, the "Nomenclator" will take the form of an index to the "Zoological Record" itself. The class of animal concerned, or in the case of insects, the order, will also be given.

A very intensive search is being made of the literature to discover names that have been omitted from existing records, and this has already resulted in the discovery of some seven hundred in insects alone, chiefly among publications that appeared between 1900 and 1920. It is hoped also to enlist the aid of all systematic zoologists throughout the world in making the work as complete as possible, and a circular asking for their help is being sent out. In the course of this, they are asked to send details of any generic names, with their original references, to Dr. S. A. Neave, of the Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7, who is supervising the undertaking on behalf of the Zoological Society of London, and will also have the assistance, in particular groups, of experts at the British Museum (Natural History).

It is hoped that the work may be completed for publication about the end of 1937, and that it will be found possible to issue it at a moderate price.

Solid Carbon Dioxide

IT is just a hundred years ago since carbon dioxide was first solidified by Thilorier. Most chemists are familiar with carbon dioxide 'snow', which has long found use in the laboratory as a convenient means of producing temperatures down to about − 80° C. The comparatively small quantities required for such purposes were obtained by the simple but wasteful method of allowing liquid carbon dioxide from a cylinder to expand through a valve into a collecting bag; in these circumstances less than 30 per cent of the weight of the liquid used is obtained in the form of 'snow'.

Until about ten years ago, the solid was only used as a laboratory freezing agent, and also in small quantities medically as a cauterising agent. For the latter purpose the 'snow' was usually pressed into a solid pencil in a mould, making it more convenient to handle, and, owing to the reduced surface exposed, less rapid in evaporation.

The commercial development of the manufacture of solid carbon dioxide became a possibility only when refrigeration began to play a large part in the organisation of food supply. A great impetus was given by the rapid growth of the ice-cream industry in the United States, where the annual production (under the familiar name of 'dry ice') rose from a few tons in 1925 to approximately 27,000 tons in 1933. In Great Britain, production on a large scale commenced several years later, but it is estimated that the output in 1934 reached 10,000 tons, and demand for the product continues to expand.

In Great Britain, the gas for the production of solid carbon dioxide is chiefly derived as a by-product from industrial processes, such as the manufacture of synthetic ammonia, and in the production of alcohol. Purification in greater or less degree depending on the source of gas is required in all cases, including the removal of odoriferous compounds and of inert non-condensable gases which, under certain conditions, and if present in sufficient quantity, would render the liquefaction of the carbon dioxide difficult or even impossible. Following liquefaction of the gas, solidification may be brought about by various processes. These, while relatively simple, are very interesting from the physico-chemical point of view; and their development on the most economic lines has been the result of much research on the phase rule and thermodynamic aspect of the system. The process most commonly adopted is to allow the liquid to expand in suitable chambers with the formation of gas and 'snow', the latter being pressed into blocks of convenient size and shape, and the gas being returned for recompression. In another process, the liquid carbon dioxide is expanded in chambers at a pressure just below that corresponding to the triple point, and solid blocks are obtained without the use of a press, while according to a third process the liquid is frozen in moulds by the rapid evaporation of liquid ammonia. As might be expected, the several processes differ considerably in thermodynamic efficiency, although this is not reflected appreciably in the cost of production, power costs being only a small fraction of the whole.

Solid carbon dioxide in its commercial form is available in blocks of cylindrical or rectangular section, weighing approximately 25 lb. These blocks have the appearance of highly compressed snow and may be cut without difficulty by means

of an ordinary saw. The temperature of the solid under a pressure of one atmosphere of carbon dioxide is − 78·9° C., but when exposed to the atmosphere is somewhat lower owing to the reduction of partial pressure of carbon dioxide near the surface of the block. On account of the low temperature, gloves should always be worn when handling the solid. In a still atmosphere, a block of the solid evaporates more slowly than might be expected, mainly on account of the low conductivity of the enveloping film of gaseous carbon dioxide and of the high latent heat of sublimation of the solid (137 cal./gm. at − 78·9° C.). Thus a 25 lb. block requires about 24 hours to evaporate completely.

The most careful measures have to be taken to prevent needless waste by evaporation both in storage and transport, and to this end heavily insulated storage bins have been designed in which the evaporation loss has been reduced to 0·5 per cent a day, while the evaporation in large railway transport containers is of the order of only 2 per cent a day. Research into the most suitable types of container and insulating material has led to the development of a range of packages suitable for the transport of solid carbon dioxide, which enables this product to be sent from the producing centre to depots in all parts of the country, and thence to the user, with a very small total loss. Although the solid can be stored for very long periods without serious loss, it has been found that a limit is set by the slow growth of the crystals, which tends to produce disintegration.

As might be expected, the principal uses for solid carbon dioxide are in connexion with refrigeration. Its dryness, high latent heat and high density (1·4) render it attractive in many cases where the cost of removing heat units is not the only consideration. As already stated, the ice-cream industry was the first to adopt this refrigerant on a large scale in place of ice and salt mixtures, and the requirements of this industry continue to expand.

A considerable field exists for solid carbon dioxide in connexion with the transport of perishables, such as meat, fish, fruit and flowers, where controlled temperature conditions are required. As a result of the work which has recently been carried out under the auspices of the Department of Scientific and Industrial Research at Cambridge and at the Torry Research Station, and by other investigators, it is now known that carbon dioxide inhibits, in a marked degree, the growth of many of the bacteria and moulds which are largely responsible for the deterioration of meat and fish, so that the value of solid carbon dioxide as a refrigerant and preservative is further enhanced on this account. In preserving flowers, however, the effect is one of arrested metabolism due to the low temperature and the presence of carbon dioxide.

It may be remarked that, although the successful utilisation of solid carbon dioxide as a refrigerant presents no serious technical difficulties, care must be taken in the design of equipment such as ice-cream conservators, refrigerated transport containers and the like, if this refrigerant is to be used successfully and economically.

Except where the low temperature of solid carbon dioxide is specially required, means must be taken to reduce the heat flow to the refrigerant, and this can be done conveniently by interposing thermal insulation between the refrigerant and the cooled chamber. A number of other methods employing a secondary liquid are available.

Reference has already been made in NATURE (Oct. 6, 1934, p. 529) to the use of solid carbon dioxide in the assembly of machine components by means of shrink fits. The effect of the low temperature in contracting metal parts is best attained by immersing the parts in a suitable low freezing point liquid containing solid carbon dioxide. In this way rapid and uniform cooling results. The advantages of this method of shrink fitting are that it enables small components, such as cylinder liners, sleeves and valve seats to be readily inserted into housings without the use of a press, thereby obviating the possibility of distortion, and that the structure of heat-treated parts is not disturbed as might be the case with hot shrinking. Solid carbon dioxide is already being used in Great Britain in the production of automobile and aero engines, locomotives and machine tools, and this application is likely to expand considerably as it becomes more widely appreciated.

The use of solid carbon dioxide as a convenient means of obtaining a supply of the liquid or gas was first realised by Elworthy who, in a patent obtained in 1898, discussed the economic advantage to be gained from handling carbon dioxide in the solid form instead of as a liquid in heavy steel cylinders. It is only recently, however, that these advantages have been secured as a result of the development of solid carbon dioxide for refrigerating purposes, and the design of suitable containers and other apparatus. Pressure vessels ('liquefiers') are now available which enable the solid to be readily converted into liquid or gaseous form, and the use of solid carbon dioxide for purposes other than refrigeration is rapidly expanding. Foremost amongst these uses must be placed the carbonation and mechanical handling of beverages for which, it is needless to say, only solid carbon dioxide of the highest purity can be employed. For example, in 'Drikold',

manufactured by Imperial Chemical Industries, Ltd., organic esters and sulphur compounds are reduced to less than one part per million, and any oil which may be carried over from the compressors is carefully removed in order to obtain a sufficiently pure product. The solid is also finding increasing use as a source of carbon dioxide for the production of salicylic acid and other chemicals.

Passing reference only has been made to some of the principal uses of solid carbon dioxide. Certain other applications are still in the development stage, while others are constantly being discovered. The development of the industry has been very rapid and constitutes one of the most remarkable modern examples of the application of scientific methods to industrial requirements.

Obituary

Prof. Arthur Thomson

ON his retirement in 1933, Prof. Arthur Thomson, whose death on February 7 will be widely regretted, had completed a somewhat unusual record of academic service. He was born on March 21, 1858, and for forty-eight years he represented human anatomy at the University of Oxford, first as University lecturer in human anatomy and afterwards as Dr. Lee's professor of anatomy. After serving an apprenticeship in the famous school of anatomy at Edinburgh under Sir William Turner, Thomson went to Oxford in 1885. Unlike many of his later contemporaries, he did not enjoy the advantage of stepping into a department already equipped for teaching and research. On the contrary, the task fell to him of building up a new department from its very foundations. It will readily be appreciated that Thomson's energies were fully employed for a number of years in developing the teaching side of his department to a level appropriate to the medical faculty of the University of Oxford, a task which was rendered very laborious at first by the criticism and opposition of some members of the University who were less ready to appreciate the importance of catering for an extensive and detailed medical curriculum.

Arthur Thomson's own contributions to scientific literature can be divided quite sharply into separate categories. Of these, his papers dealing with the racial variations of the skeleton are the most noteworthy. In this work he was clearly influenced by his late teacher, Sir William Turner, who had stimulated considerable interest in racial anatomy by his studies of the human skeleton in the *Challenger* Reports. Thomson's work on this subject was characterised by the fact that he constantly sought to explain by reference to habits of life and environmental influences the osteological variations which were being at that time recorded by anatomists. He was not content simply with measurements and with the construction of indices, and he was evidently reluctant to accept metrical variations of the skeleton as necessarily of real morphological significance in the assessment of racial affinities. In 1889 he showed the importance of considering posture as a factor in the determination of the proportions and contour of the lower limb skeleton and directed attention to the 'squatting facets' on the tibia and talus. In the same year he published an anthropometrical study of the Veddahs of Ceylon. His interest in craniology led him to investigate the significance of cranial indices which were then assuming such importance in the eyes of the anthropologist. By ingenious models he sought to show that the proportions of the calvarium must be directly influenced by brain volume and by the action of the temporal muscles. These observations were published in the *Journal of the Anthropological Institute* in 1903, and his conclusions, which were admittedly tentative, have in some part been substantiated by statistical study on a larger scale.

In 1913, Thomson made a valuable communication on the correlation of isotherms with variations in the nasal index. Ten years later, this observation was submitted to statistical analysis by him in collaboration with Dr. Buxton, with the noteworthy conclusion that a platyrrhine nasal index is associated with a hot moist climate and a leptorrhine index with a cold dry climate. Other studies by Thomson in this line include a comprehensive study with D. Randall-MacIver of Egyptian crania, published in 1905 by the Clarendon Press under the title of "The Ancient Races of the Thebaid", and a paper on the genial tubercles of the mandible in 1915. At Oxford, Thomson will be particularly remembered with gratitude for the part he played in instituting and organising the regular course of study for the University diploma in anthropology, a course which has met with increasing success since its initiation in 1907.

Thomson was a close personal friend of the late R. W. Doyne, who founded the Oxford Ophthalmological Congress, and undoubtedly it was this friendship which led him to make special studies of the anatomy of the eye. This resulted in the publication of two papers on the filtration angle of the eye in 1910 and 1911, and in a brochure on the anatomy of the human eye together with an atlas of stereoscopic photographs of dissections of the eye.

Thomson's last work was concerned with the microscopic structure of the human Graafian follicle and the maturation of the human ovum. These provided the subjects for two papers in the *Journal of Anatomy* in 1919.

Apart from his work at the University of Oxford, Thomson occupied the position of professor of anatomy at the Royal Academy, to which he was elected in 1900. In this sphere he was able to give full expression to his own artistic propensities, and he left an appropriate memorial of his contribution to art in his book "Anatomy for Art Students" which has passed through a number of editions.

PROF. J. MACMILLAN BROWN

WE regret to record the death of Prof. J. Macmillan Brown, chancellor of the University of New Zealand, and well known as an authority on the peoples of the Pacific, which took place at the age of eighty-nine years, at Wellington, N.Z., on January 18.

John Macmillan Brown was born at Irvine, Scotland, in 1846, the son of Mr. James Brown, shipmaster, and was educated at the Irvine Academy, the University of Glasgow, and Balliol College, Oxford, of which he was an exhibitioner. In 1874, on the establishment of Canterbury University College, he went to New Zealand to take up the appointment of professor of classics, and later became professor of English literature. In 1877 he became a member of the Senate of his University, and in 1923 was elected chancellor, an appointment which he held until his death.

Macmillan Brown was best known in England for his work on the problems of the Pacific, and more particularly for his somewhat speculative theories on the origin of the Polynesians and of the remarkable artistic products of Easter Island. His views were set forth in considerable detail and fully argued in his books "Maori and Polynesian", "The Riddle of the Pacific" (1924), and "Peoples and Problems of the Pacific" (1927). In the view put forward in the "Riddle of the Pacific" he argued that the famous statues of Easter Island are the product of workers on what was a mausoleum for a circle of islands, which have since disappeared owing to volcanic action. His theories of the peopling of the Pacific, which proved stimulating, if not entirely acceptable, brought the Polynesians as a Caucasic element from Asia, a primeval form of Indo-European. Whatever may be the ultimate verdict on his philological and ethnological theories, they undoubtedly had a stimulating effect in promoting the study of the peoples of the Pacific in New Zealand.

MR. FRANCIS J. BLIGHT

OLD scientific friends of Mr. Francis J. Blight will learn with much regret of his death at the age of seventy-seven years, on January 27 at his home at Mill Hill. Previously to 1927 he had been closely associated with Messrs. Charles Griffin and Co., Ltd., the well-known publishers of technical scientific books, and since 1899, when Miss E. E. Griffin died, he had been chairman and managing director of the firm, only retiring in 1927 in consequence of rearrangements following on the death of Miss Helen Griffin.

In early life, Blight, whose father and grandfather had been booksellers and stationers, had been for some years engaged in office work connected with iron and steel works, railway and other architecture, map-making, etc. He had thus become an expert draughtsman, with a wide knowledge of technical processes of many different kinds. In 1886 he became assistant manager to Messrs. J. and A. Churchill, the medical publishers, and in 1894 manager for Messrs. Griffin, then under the able chairmanship of Miss E. E. Griffin. Quickly realising the wide need for technical scientific books of all kinds, he developed this side of the firm's business with extraordinary energy and success, bringing out textbook after textbook which had large sales.

It was to a very great extent Blight's own personality that led to these books being written. He not only suggested them in many cases to men who, he saw, were likely to write them well, but also in their actual production was extremely helpful, particularly perhaps as regards the illustrations. It was an extraordinary stimulus and encouragement to meet him, as the writer of this short notice often did, in the well-known room at Exeter Street which was pervaded by his genial presence.

In 1920 a volume was published in celebration of the centenary of the Griffin firm, which had originated early last century at Glasgow. This volume contains sections dealing with the more recent publications of the firm in scientific technology, and written by Prof. Barnett, Sir T. Hudson Beare, Sir W. S. Abell, Prof. W. Gowland, Prof. Henry Louis, and other well-known authors. In a foreword to the volume, Lord Moulton stresses the national importance of technological publishing, and remarks that to Mr. Blight "the exceptional prosperity of the Firm, and its services to the country during the late war, must be primarily ascribed".

Only brief mention can be made here of another side of Blight's life. He was a keen supporter of the Baptist Church, and particularly of its charitable activities with respect to children and young persons. He also strongly supported all that has been done in this direction by State action and municipal activity. He was a man of simple character, in which love of his fellow-men was never overshadowed by either business or scientific interests. J. S. H.

MRS. JANE LONGSTAFF, who died on January 19, aged seventy-nine years, contributed important papers on Palæozoic gastropod shells to the *Quarterly Journal of the Geological Society*. She was the widow of Dr. G. B. Longstaff, a well-known entomologist, with whom she shared a wide interest in natural history. She was a fellow of the Linnean and Geological Societies, and was for some time a member of council of the Palæontographical Society. Her early writings were published under her maiden name of Jane Donald, and the value of her researches was acknowledged so long ago as 1898, when the Geological Society awarded her its Murchison Fund.

WE regret to announce the following deaths :

Mr. J. H. Benyon, Lord Lieutenant of Berkshire and chancellor of the University of Reading, a leading figure in agriculture and stock-breeding, on February 14, aged eighty-five years.

Prof. Bohuslav Brauner, lately professor of chemistry in the Charles' University, Prague, sometime Berkeley fellow of Owens College, Manchester, on February 15, aged eighty years.

News and Views

Robert Hooke's Diary

THE tercentenary of the birth of Robert Hooke, Gresham professor of astronomy, surveyor to the City of London and curator of experiments to the Royal Society, occurs on July 18 of this year. Hooke appears to have kept a continuous diary for the greater part of his life ; and parts of his daily journal have been found in three different libraries. The importance of the first part was realised by Dr. Jean Pelseneer of Brussels, who directed the attention of the Royal Society to its existence in 1928 ; with the permission of the authorities of the Guildhall Library, Mr. H. W. Robinson made extracts, some of which were published by Dr. Pelseneer in *Isis* (February 1931). Afterwards, Mr. Robinson discovered another and later part of the diary in the British Museum, where for more than a hundred and sixty years it had been catalogued as the diary of James Petiver. The Guildhall portion of Hooke's diary is the most important, and is full of interest from all points of view. It records meetings of the Royal Society of which no minutes occur ; elections of which there are no official records extant ; details of his work as architect, surveyor and contractor ; his daily visits to the coffee-houses and taverns, where he joined in the discourses and gossip of the city men ; details of his private life, his income, his purchase of books and necessaries of life.

BY the courtesy of the Library Committee of the Guildhall, the part of Hooke's diary in the Guildhall Library can now be published. For many years Mr. H. W. Robinson and Mr. W. Adams have been carefully transcribing the diary, and it will be published, together with a short life of Hooke, by midsummer. The work of printing and publishing has been entrusted to Messrs. Taylor and Francis, who have undertaken to produce the book with the aid of a subsidy from the Royal Society. Of more than passing interest is the fact that the house occupied by Messrs. Taylor and Francis is supposed to have been built during the period of the diary, and most probably by Sir Christopher Wren and Robert Hooke. It may be remembered that Dr. R. T. Gunther has already published three volumes of Hooke's works in his series of books on "Early Science in Oxford".

Tribal Justice in Australia

A PERTINENT example of the practical bearing of the results of anthropological investigation is afforded by the defence set up in a trial for murder of two aborigines from Alice Springs, South Australia. The facts of the case are set out in a dispatch from the Adelaide correspondent of *The Times* in the issue of February 15. The defence rested on a plea of tribal justice. It has been put forward that the two accused were acting in accordance with custom and under the instructions of the elders of the tribe in putting to death a man who had revealed ceremonial secrets to a woman. Failure to comply, it was stated, would have entailed death. As might be expected, anthropologists have not failed in the endeavour to bring the aboriginal point of view before the court. Expert witnesses, however, were not heard ; but their special knowledge was placed at the service of the defence. Ever since Spencer and Gillen first recorded, nearly forty years ago, the special reverence of the natives of Alice Springs for everything pertaining to tribal ceremonial, anthropologists would have been prepared to expect death as the logical consequence of so grave a threat to tribal safety as the breaking of taboo involved in the disclosure of ceremonial objects or procedure to a woman. It is, at the very least, the equivalent of a combination of high treason and sacrilege in a civilised community. As recent trials in Africa have shown, a court rooted in European law is not prepared to admit that in such cases tribal justice may demand and exact the supreme penalty, in the manner in which in a civilised society a traitor who discloses State secrets may be imprisoned for life or condemned to death. Those who carry out the sentence of the tribe must, in accordance with the laws of the country, be adjudged guilty of murder, even though the extreme penalty may not eventually be imposed.

Organisation of Agriculture in Australia

DIFFICULT circumstances in the agricultural industries of Australia are giving rise to much-needed co-operation between Commonwealth and States. In December last a conference of ministers at Canberra determined to establish an Australian Agricultural Council, to provide for continuous consultation among the Governments on economic aspects of agriculture, the members to be the Federal Minister for Commerce, the Minister-in-Charge of Development and Scientific Research and the State ministers concerned. This body will be supported by a permanent technical committee which is identical in personnel with the former Standing Committee on Agriculture of the Council for Scientific and Industrial Research, but which will now have greatly increased responsibilities. Its members are the six permanent heads of the State Departments of Agriculture, the three executive members of the Council for Scientific and Industrial Research, the Secretary of the Department of Commerce and the Director-General of Health. Besides its duties on the side of agricultural economics, this committee is charged with (i) securing co-operation and co-ordination in agricultural research throughout the Commonwealth ; (ii) advising Commonwealth and State Governments, directly or through the new Council, on matters pertaining to the initiation and development of research on agricultural problems ; and (iii) securing co-operation between Commonwealth and States, and between the States themselves in all quarantine measures relating to pests and diseases of plants and animals, and advising Governments thereon.

Training in Food Technology

THE Food Group of the Society of Chemical Industry met on February 13, at the London School of Hygiene and Tropical Medicine, to take part in a discussion on "The Training of the Food Technologist", opened by Dr. H. B. Cronshaw, editor of *Food Manufacture*, the *Industrial Chemist* and other publications. As Dr. Cronshaw's paper had been circulated before the meeting, he gave a brief summary of the more contentious parts and showed a number of slides illustrating numerous institutions, chiefly in North America, at which research and teaching in food technology are combined to various degrees. The main part of Dr. Cronshaw's paper, however, and that which gave rise to most discussion, contained a plea for the introduction in Great Britain of special post-graduate courses in food technology at suitable universities and colleges. Dr. Cronshaw's paper included a comprehensive and very useful survey of the kind of problems with which the food technologist is likely to be confronted, as well as some ingenious classifications of the type of product with which these technologists have to deal. For this reason alone its publication in full in *Food Manufacture* will be anticipated with much interest. His main plea, however, was subject to considerable criticism by various members of the Society, particularly on the grounds that it tended to overemphasise the need of specialised technological knowledge in the young post-graduate entering industry, and so to run the risk of supplying him inadequately with the essential scientific outlook. Some of the discussion also directed attention to the importance of considering pre-graduate as well as post-graduate studies, and even of elementary and secondary education.

Museum of the History of Science at Oxford

ON February 12 Congregation at Oxford unanimously passed the statute which alters the name of the institution housing the Lewis Evans and other collections of scientific instruments to the "Museum of the History of Science, Old Ashmolean Building". The first step towards the full recognition of this institution—hitherto governed by decrees—has thus been taken. The museum is to be administered by the Vice-Chancellor, the Proctors and six others, three of whom will be appointed by the science boards. At the moment there will be no extension of the premises. A decree, however, was also passed assigning the main ground-floor room of the Old Ashmolean to the museum at a date not later than 1942. This room, where in the past the New Oxford Dictionary was compiled, and the present upper-floor room, where the collections now are, should be adequate for the museum for many years. It is a pity, however, that this increased accommodation, at the moment badly wanted, cannot be definitely secured earlier, and that the University cannot promise adequate financial support for the staff in charge. It is to be hoped that such help will soon be forthcoming, so that the museum may take a bigger part in the science teaching in Oxford—an opportunity for a generous donor. Congregation expressed themselves very appreciative of the work of Dr. R. T. Gunther, the curator, who not only created the museum single-handed more than ten years ago, but also has since given his services as administrator and teacher for a purely nominal salary.

Pollution at Sea by Discharge of Oil

IN July last, the British Government, stating that representations had been made to it that the pollution of the coasts of the British Isles by the discharge of oil and oily matter outside the territorial limits by ships was increasing, suggested that the matter be referred for preliminary examination to the Communications and Transit Organisation of the League of Nations, with the view of concluding if possible an international convention. At the last Assembly, this view was further explained by the British representative and it was decided that an initial inquiry should be undertaken. Experts from Denmark, France, Italy, Japan, the United States and Great Britain were invited to Geneva by the chairman of the Advisory and Technical Committee on Communications and Transit. These experts agreed that oil pollution caused the destruction of sea-birds, the wings of which become saturated with oil so that they cannot swim, fly or dive; of fish, particularly shellfish, and of the marine grasses which form the staple food of fish and sea-birds. The pollution of sea-beaches by oil results in harm to bathers and depreciation in value of seaside resorts, and constitutes a menace to public health; finally, the accumulation of oil drifting into harbours offers a serious risk of fire. These evils exist to a varying extent in many countries and the object in view is to provide, by international agreement, some means whereby oil-burning and oil-carrying ships may be prevented from polluting, through the discharge of oil and oily mixtures on the high seas, the coasts to which the matter is liable to drift. Some causes of pollution such as collision, or the pouring of oil on to the sea during storm to assist vessels in distress, cannot be prevented, but it is possible by co-operation to guard against voluntary discharge outside territorial limits, and the Committee of Experts recommend that an appropriate international convention should be concluded.

Security of Tenure and Intensive Farming

THE private bill promoted by the Metropolitan Water Board, which may involve the destruction of Holly Lodge Farm (see NATURE of February 2, p. 177), was read a second time in the House of Commons on February 18. Sir A. Boyd-Carpenter moved that an instruction be given to the committee which is to consider the bill to leave out works on this site, on account of the unique value of the farm as a research centre. After discussion, Sir Hilton Young, Minister of Health, pointed out that he had consulted the Minister of Agriculture on the matter and it was agreed that the appropriate means of dealing with the question was to refer it to a committee of the House. Sir A. Boyd-Carpenter's motion was then by leave withdrawn. In a letter in *The Times* of

February 15, Sir William Prescott, chairman of the Metropolitan Water Board, stated that the "site for the proposed reservoir at Walton has been selected after the most exhaustive examination of other available lands". It is not stated whether the expert opinion available to the Ministry of Agriculture or to the Geological Survey has been sought, but it is much to be hoped that such scientific advice may be consulted before the matter comes under discussion in committee of the House of Commons.

A New American Balloon Ascent into the Stratosphere

FOLLOWING on the American ascent into the stratosphere last year recorded in NATURE of July 28, p. 132 and November 3, p. 707, 1934, careful inquiry has now shown that the mishap was caused by internal adhesions of the lower part of the balloon fabric. Plans for a new ascent are well advanced. The personnel of the advisory committee has been chosen by the National Geographic Society working in co-operation with the United States Army Air Corps, and once again Capts. A. W. Stevens and O. A. Anderson will ascend. It is gathered from the announcement by the president of the Society in the *National Geographic Magazine* of February 1935 that the arrangements will differ but little from those of last year's flight. The balloon will have the same capacity and the ascent will be made from the same place. No details are as yet available of the instruments that will be carried, but as the lifting power will be about six tons and as "special emphasis is to be placed on data that can be obtained from manned balloons capable of lifting standard laboratory instruments", there is no doubt that every possible self-registering device that might supply information about the upper atmosphere and cosmic rays will be included. An advisory committee under the chairmanship of Dr. Lyman J. Briggs, director of the U.S. Bureau of Standards, is to be congratulated on the thoroughness of its investigations of the previous failure. The findings will be of greatest value to those who undertake future hazards.

A New Diphtheria Prophylactic

OWING to the prevalence of diphtheria during the last year, a considerable demand has followed for immunising agents for preventive inoculation, which is now extensively practised with good results. Various agents have been employed for this purpose, such as toxin-antitoxin mixtures and preparations of modified diphtheria toxin known as 'toxoid'. An alum-precipitated toxoid (A.P.T.) of high immunising efficiency is now available, and is issued by Messrs. Burroughs Wellcome and Co., in germ-proof containers of 1 c.c. and 5 c.c. This substance was first prepared in the Wellcome Physiological Research Laboratories in 1926. The results of animal tests showed that it possessed considerable immunising power against diphtheritic infection, and since that date its high immunising efficiency in human beings has been established. Caution has been exercised in applying the inoculation of A.P.T. in human beings on account of the production of a tissue response at the site of injection. This, though medically trivial, may disturb parents of inoculated children. The efficiency of A.P.T. probably depends upon the deposition of the relatively insoluble aluminium-toxoid compound at the site of injection, and from this the immunising toxoid is gradually liberated. The complex toxoid compound, however, excites a tissue response in the form of a small painless nodule, and this tissue response is probably an essential factor in the potent immunisation that ensues. Unpublished experiments made in the Wellcome Research Laboratories have shown that in animals two spaced injections of one tenth, or less, of the ordinary human dose results in a more rapid, or a higher, immunity than one single larger dose. It is possible that a similar method may prove useful in human immunisation, the chance of troublesome local reaction being lessened by this course.

Juan Fernandez and Easter Island

BY a recent decree of the Chilean Minister of Lands and Colonisation, it is reported by a correspondent of *The Times* in the issue of February 14, Juan Fernandez and Easter Island have been declared national parks. This gives effect, so far as Juan Fernandez is concerned, to a proposal which was first put forward so long ago as 1921. The two volcanic islands grouped together under the name Juan Fernandez and situated four and five hundred miles respectively west of Valparaiso are of popular interest because it was on one of them that Alexander Selkirk was marooned from 1704 until 1709; and his adventure is supposed to have inspired Defoe in writing "Robinson Crusoe". Easter Island, on the other hand, which lies about 2,300 miles from the mainland, is one of the most interesting islands of the Pacific. Its archæological remains present a problem for ethnologists which hitherto has defied satisfactory solution. These remains consist of more than five hundred human figures, portrait statues, carved in stone, some of gigantic size and one at least approaching forty feet in height, over two hundred stone platforms and stone houses, unique in the Pacific, relics of a race of which the present inhabitants have no knowledge. Even more interesting in certain respects are the tablets inscribed in a script which no one has yet succeeded in deciphering. Since 1888 the island, which has an area of about 48 square miles, has been in the possession of Chile, and has served as a penal settlement. The native inhabitants, who are Polynesians with a Melanesian strain, barely exceed 200 in number, though in 1860 they numbered 3,000; but in the 'seventies a considerable proportion migrated or was removed to Tahiti and the Gambier archipelago. The decree of the Chilean Government, in so far as it will ensure the protection from vandalism of these unique relics of an otherwise unknown culture and an apparently vanished race, is a public-spirited act worthy of the highest commendation.

A Tidal Power Project in the Bay of Fundy

THE Bay of Fundy is well known throughout the world for the height of its tides. It is not surprising, therefore, that Americans are interested in the

project for getting tidal power at Passamaquoddy Bay, which lies between New Brunswick, Canada, and Maine, U.S.A. A full description of the project is given by H. E. M. Kensit in *World Power* of February. The projected power house is situated entirely in the State of Maine, but as the project is an international one, the power produced would be equally divided between the two countries. If we compare the estimated cost of the new project with that of the corresponding tidal power schemes in England (the Severn) and in the Argentine (San José) it comes out decidedly cheaper. In the English scheme, the cost of a horse-power is £31·4, in the Argentine it is £25·3 and at Passamaquoddy it is £18·9, and each is roughly of the same size. The normal spring tides at the head of the Bay of Fundy range between 47 ft. and 52 ft. The maximum recorded tide occurred in 1869 and was nearly 57 ft. At the site of the new power station, the tides will lie between 17 ft. and 19·5 ft. In 1930, President Hoover induced Congress to defray half the cost of a joint investigation with Canada into the effect of such a station on fisheries. In this connexion, it is of interest to know that the committee on the Severn project decided that a large number of sluices open for many hours every day would obviate any detriment to fishing interests. It is probable therefore that the joint commission on fisheries may present a favourable report. The United States engineers indicate that there is no insuperable difficulty with regard to shipping interests, and many are hoping that this great enterprise will be carried out by private interests and capital.

Habits and Evolution

At the annual conference of the School Nature Study Union, held in January, Prof. E. W. MacBride was the speaker, and his address upon "The All-importance of the Study of Habits for the Knowledge of Evolution" was, in effect, a statement of his evolutionary faith (*School Nature Study*, 1935, p. 2). He led to his own viewpoint by a vigorous onslaught upon the faiths of others. Evolution we all accept, but the way thereof is dark. Darwin, we learn, with his natural selection of variations, was a false prophet, for natural selection does not work even if small deviations were heritable, which they are not. The mutationists are equally in error, for a mutation is a suddenly produced disturbance of development which persists only so long as the conditions producing it continue. According to Prof. MacBride, the truth lies with the neo-Lamarckians in their belief that use and disuse, in short habit, have been the mainspring of the progress of evolution. "Habit long persisted in does affect posterity and is the driving force in evolution; the personality, if we may use such a word, of a living being, is made up of a complex of inherited habits, and habits deeply ingrained are extraordinarily persistent." Prof. MacBride supports his thesis and trounces his opponents by quoting experimental results well selected for his purpose. Thirty years ago no biologist would have listened to the Lamarckian view; nowadays we are not so sure.

Scheme for Eradication of Cattle Tuberculosis

The Ministry of Agriculture and Fisheries has issued a document describing 'arrangements' made by the Ministry under Section 9 of the Milk Act, 1934, for promoting the establishment of cattle herds officially certified to be free from tuberculosis. Any owner who has taken steps to eradicate the disease from his herd, and is a 'registered producer' under the Milk Marketing Scheme, is entitled to apply to the Ministry for an official test of his herd, providing no reactors were found in the herd at the last two tests made under certain conditions on the owner's behalf. If the owner satisfies the Ministry as to the management and conditions of herd and farm, and agrees to observe the regulations, an official tuberculin test of the herd will be made by the Ministry free of charge, and provided no reactors are found, the herd will be placed upon a 'register of attested herds'. The scheme, which is a voluntary one, came into operation on February 1, and owners who desire to avail themselves of it should communicate with the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, London, S.W.1. One advantage of attestation is that the owner will be entitled to a bonus of 1*d.* per gallon for all milk sold under the marketing scheme of the Milk Marketing Board.

Iodine and the Thyroid Gland

In the twenty-ninth Bedson Lecture delivered on February 8 in Newcastle, Prof. C. R. Harington dealt with the relation of the thyroid gland to iodine. He traced in detail the parallel histories of the anatomy, physiology and pathology of the gland, culminating in the work of Kocher, the treatment with sheep gland extracts by Murray, and the iodine treatment by Coindet of goitre and cretinism. Although the 3 : 5-diiodotyrosine also present in the 'colloid' must take part in the activity, as this is proportional not to total thyroxine but to total iodine, the two di-peptides made from them have not proved to show the full activity, so that possibly they are linked to, or by, other amino-acids, it being fairly established that no other compound of iodine is present. The general picture, then, is as follows. Iodine is readily taken up by the gland with formation of 3 : 5-di-iodotyrosine, which is elaborated into the globuline; this is the storage form, the so-called 'colloid', of the epithelial layer. When total iodine in the gland falls below 0·1 per cent, the colloid is soon exhausted and the epithelium extends to form goitre. Later, generally in pre-natal conditions, atrophy occurs leading to cretinism. Restoration of iodine at the former stage leads to distension by colloid, and the epithelium reabsorbs. In the normal state the tyrosine derivative is partly converted into thyroxine, and these two substances form the hormone which regulates bodily metabolism in general. In support of this view, it has been shown by Prof. Harington that the tyrosine and thyroxine are of the same stereochemical configuration by the preparation from each of thyronine (desiodo-thyroxin).

Ideal Home Exhibition

THE nineteenth *Daily Mail* Ideal Home Exhibition will open at Olympia, London, on March 26. A feature of the Grand Hall will be the great murals, 36 ft. high and 374 ft. long, from end to end of each side of the hall. The eighteen panels will bring to the eye, not only the vivid story of the changing world but also the actual features of more than a thousand men and women—pioneers, social workers, explorers, scientific workers, engineers, industrialists and others who have achieved distinction in helping to change the world for the better. This work has been carried out to the original designs of Oswald Cuningham. Among the features of the Exhibition will be a £50,000 installation of the very latest types of British-made canning machinery, weighing nearly 40 tons, to demonstrate the rapid strides made by this new home industry. Twenty-five years of progress in things engineering and scientific will be found on the second floor of the Empire Hall—the development of electric lighting, telephones, aviation, travel, transport, sound-recording, reproduction and radio. The General Post Office will have in operation the latest of the many wonderful machines utilised in modern communications. The strides made by 'staybrite' steel, which made its debut at the exhibition last year, will be demonstrated, and there will be numerous exhibits of beauty and utility for the home for furnishing, lighting, heating, decoration, labour-saving and recreation.

Improving Long-Distance Telephone Transmission

THE rapid improvement of the technique of radio communication during the last ten years is now having a beneficial influence in the development of long-distance telephone transmission. In particular, the improvements made in vacuum valves due to the demands made by broadcasting engineers have led directly to great improvements in the design of the repeater valves used in long-distance telephony. It is well known that during conversation over long lines by means of carrier frequency equipment the sounds heard sometimes vary greatly in loudness. This is attributed to the fact that the attenuation of the line, especially when overhead wires are used, changes with climatic conditions, temperature, etc. With cable circuits, the loudness remains much more constant. The phenomenon is analogous to the well-known phenomenon of 'fading' in radio transmission. Successful attempts have recently been made to mitigate this trouble. A paper by H. Sterky and R. Stalemark which appears in *Ericsson Technics*, No. 3, 1934, describes an automatic method of compensating for these variations which has been used in practice for the last two years with good results. The development of the method is due to the telephone firm of Ericsson, Stockholm. It depends on the well-known mathematical theorem that a carrier wave modulated by a wave of voice frequency is equivalent to three separate simultaneous oscillations. One of these has the frequency of the carrier wave; the others, called side-band waves, are of higher and lower frequency respectively. In the Ericsson device, during conversation, the carrier and one side-band wave are transmitted. Signalling is done by modulating the carrying wave with the 'ringing' current. It is stated that the volume control of the sound obtained in this way is very good.

Shellfish and the Public Health

THE Minister of Health has issued an Order, Public Health (Shell-fish) Regulations, 1934, revoking previous regulations, and regulating the sale of shellfish for human consumption, which came into operation on January 1. The new regulations give powers to local authorities to investigate suspected layings, to prohibit the sale of shellfish from polluted layings, and to provide cleansing apparatus if considered necessary (Statutory Rules and Orders, 1934, No. 1342. 2*d*. Circular 1446. 1*d*. H.M. Stationery Office).

International Office for the Protection of Nature

THE Belgian Government has by Royal decree officially recognised the International Office for the Protection of Nature, Rue Montoyer 21, Brussels, and has appointed the following delegates to be its representatives on the General Council of the Office: Delegates for Belgium, Baron E. de Cartier de Marchienne, Belgian Ambassador in London, and Count Henry Carton de Wiart, former Prime Minister; Delegates for the Belgian Congo and the Mandated Territory of Ruanda-Urundi, P. Charles, Minister of Colonies, and Prof. V. Van Straelen, director of the Royal Belgian Museum of Natural History and president of the Institute for National Parks in the Belgian Congo.

Oxidation-Reduction Potentials in Bacteriology

THE fact that a second edition of Dr. L. F. Hewitt's monograph on "Oxidation-Reduction Potentials" has been found necessary indicates the interest taken by biologists in the subject ("Oxidation-Reduction Potentials in Bacteriology and Biochemistry": published by the London County Council. Pp. 81. 2*s*.). Since the first edition was noticed in our columns (NATURE, **128**, 73; 1931) the subject has advanced steadily, and the author has taken the opportunity to revise and extend the text and bring the bibliography up to date. The study of electrode potentials is proving of assistance in the practical question of the rationalisation of culture media and cultural conditions, and is throwing light upon the biological behaviour of organisms, such as the maintenance or loss of virulence, questions of great importance in medical practice.

Improvement of Grassland

As much as eighteen million acres in England and Wales consists of grassland, and considerable attention has been paid in recent years to its improvement. The need for authoritative information on this important subject led to the publication of Bulletin No. 3, "The Improvement of Grassland", by the Ministry of Agriculture and Fisheries, a fourth and revised edition of which has been issued (1*s*. net). The revision of the text has largely been carried out by Prof. J. A. Hanley (Armstrong College, Newcastle-

upon-Tyne) who has taken the opportunity of incorporating in the present issue the deductions drawn from the work done under the Ministry's 'Grassland Campaign', and also to include a section on the comparatively new system of rotational or 'managed' grazing. The sections on the renovation of worn-out grassland and seed-sowing remain substantially as written by Prof. R. G. Stapledon, of the Plant Breeding Station, Aberystwyth.

Medical Research in South Africa

THE annual report by the director, Sir Spencer Lister, of the South African Institute for Medical Research, Johannesburg, gives an account of the routine and research work of the Institute for the year 1933. Concentrated anti-plague serum, prepared in the Serum Department, has been tested experimentally, and has been found to have four times the protective and curative power of the unconcentrated serum, concentration being in the same ratio. Considerable difficulty has been experienced in maintaining the virulence of the plague bacillus in culture, and this difficulty has not yet been overcome. The study of pneumonia as it occurs among native miners of the Witwatersrand goldfields was continued, and the work confirms previous findings that the disease is not a pure pneumococcus pneumonia of the earlier days of the Rand, but that other organisms are associated with, or replace, the pneumococcus, namely, the streptococcus, staphylococcus and influenza bacillus. During the year, a case of human rabies due to a cat bite was observed; the incidence of human rabies infection is on the increase in South Africa, being conveyed by the cat, the tame meercat, and occasionally the dog. The observations upon dust estimation and control in the mines have been extended, and research upon several other subjects has been continued.

Astronomical Phenomena in March

MERCURY is now a morning object, and attains its greatest elongation of 28° W. on March 15. Venus, on the other hand, is moving round to its greatest eastern elongation (45° E. on June 30) and has already become a conspicuous object in the evening sky just after sunset. Mars is well placed for observation, being very nearly in opposition. Jupiter is a morning object, and Saturn is very near the sun. An interesting conjunction of Venus and Uranus will occur on March 22 at 7 hours, when the planets will only be separated by 0·4°. This conjunction will, of course, be invisible in England, but the two planets should be seen close together, in a small telescope, on the evening of March 21 or of March 22. Neptune is well placed for telescopic observation, being in opposition to the sun on March 4.

Announcements

PROF. W. J. DE HAAS, University of Leyden, informs us by cable that on February 15 he succeeded in reaching a temperature only five thousandths (0·005) of a degree above absolute zero. Particulars of this remarkable achievement will be awaited with great interest.

AT the annual meeting of the Royal Society for the Protection of Birds to be held at the Westminster Palace Rooms, 44 Victoria Street, S.W.1, on Friday, March 1, Her Grace the Duchess of Portland, president of the Society, in the chair, a motion will be submitted "That the Governments of all maritime nations be urged to give the strongest possible support to the League of Nations in their endeavours to secure the universal adoption of effective measures for preventing the pollution of the seas by oil".

IT is proposed to hold an exhibition of English periodicals and reviews in the library of the University of Coimbra, Portugal, early this year. It is hoped later to transfer the exhibition to Lisbon, Oporto and Braga. It appears that English is the second foreign language in Portugal, and a large proportion of its inhabitants have a working knowledge of the language; but there is a general ignorance of what periodicals and reviews are published in English. It is hoped that the exhibition will remedy this state of affairs. Further information can be obtained from the Director, Biblioteca da Universidade, Coimbra, Portugal.

REFERRING to Mr. C. R. Cosens's letter in NATURE of January 12 (p. 71) on "Designation of Logarithms to Base e", Dr. J. Satterly, of the University of Toronto, writes: "Long ago I decided that logh was too long and $\log_{10}$ and $\log_e$ awkward and have recently designated for blackboard work common logarithms and natural logarithms as 'ln' and 'lc', pronounced something like 'Ellen' and 'Elsie' respectively."

A BOOKLET dealing with the chloramine group of antiseptics has been issued by Boots Pure Drug Co., Ltd., Station Street, Nottingham, from whom it may be obtained free of charge. Attention is directed to the use of 'chloramine-T' and 'dichloramine-T' in the treatment of infected wounds, and to 'halazone', a most satisfactory chlorine compound for the sterilisation of drinking water.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A computer (class II) to the Ordnance Committee, Royal Arsenal, Woolwich, S.E.18—The Secretary (Feb. 25). A lecturer in electrical engineering at Chesterfield Technical College—The Director of Education, County Education Office, St. Mary's Gate, Derby (Feb. 25). A University lecturer and a part-time University lecturer in the Faculty of Mathematics, University of Cambridge—The Secretary to the Faculty Board of Mathematics, St. John's College, Cambridge (March 2). Junior scientific officers in the Aerodynamics and Radio Departments of the National Physical Laboratory, Teddington—The Director (March 4). A resident lecturer (chemistry or physics) at Girton College, Cambridge (March 6). An assistant lecturer in zoology in the University of Bristol—The Secretary (March 11). A Henry George Plimmer fellowship in pathology at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7—The Rector (June 17).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 310.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Deep Diathermic Effect and Localisation by Means of 'Auxiliary Dielectric Electrodes' in the Condenser Field

AT present it is impossible to heat the deeper parts of a body of uniform transverse section and homogeneous structure to a higher temperature than its peripheral parts by means of high-frequency currents. With present-day methods the loss of oscillating energy by leakage and radiation is so great that probably less than 20 per cent of it is used for heating effects. Further, it is impossible to localise, to concentrate or even to direct the field more than very vaguely. Any object brought into the field deforms it in an uncontrollable way.

I have found a method by which the condenser field can be made to produce a greater effect at the deeper parts than at the peripheral parts by the use of 'auxiliary dielectric electrodes'. Between the two metal plates, of 2–3 in. diameter, of the high-frequency apparatus is placed a glass tube, about 4 in. long and half an inch in diameter. Near one end is a side tube for filling. The ends are closed by flat glass walls. An air space of ½ in. is interposed between the metal electrodes and the glass ends. The tube is filled with white of egg. On exposure to the field, coagulation commences at the middle of the tube and gradually extends towards the ends, which remain cool. The coagulation does not occur if the long axis of the tube is parallel to the electrodes. If in this position suitable cylindrical auxiliary dielectric electrodes, one to two inches in diameter, made of agar, wax, ebonite, etc., be placed so as to occupy the space between the metal electrodes and the tube and be in contact with electrodes and tube, then coagulation occurs in that part of the tube which lies between the auxiliary electrodes. If we arrange the tube again lengthwise and apply a short dielectric cylinder to one end, a longer one to the other, the point of coagulation will be moved towards the longer dielectric. Different shape or different material of one dielectric may modify this effect.

A similar experiment can be performed with minced muscle, liver, kidney, etc. In some experiments it was possible to heat a 580 gm. piece of ox-liver to a considerably higher temperature in the centre than at the borders. For example, thermometers 0·6 in. from each side, and a thermometer in the middle and so 2·5 in. from the sides, registered as follows :

	Left edge	Centre	Right edge
Starting temperature	12°	9°	11°
After 10 minutes	15·8°	15·6°	15°

At this time the temperatures throughout the piece might be considered as equal. The room temperature was 18·5°. The following temperatures were reached :

After 10 minutes	19·6°	23·3°	18·3°
After a total of 60 minutes	31·7°	40·7°	31·2°
Total rise	19·7°	31·7°	20·2°

Of course, in the living animal such differences will scarcely be obtainable, except in quite special circumstances, on account of the considerable heat convection by the circulating blood and lymph. The effect is nearly the same for any wave-length between 3 and 30 metres.

These experiments prove the possibility of deep-heating, of localising and of concentrating the lines of force and of directing the field. A further advantage is the considerable reduction of the losses by leakage and radiation ; the loss in the dielectric itself depends on its transparency for these waves.

Differences in the size of cross-sections of different parts of the object cause an increased heating-effect on the site of the smallest sections, and prominent points or corners sometimes heat up quickly. This inconvenience can be overcome by moulding the dielectric substance around or partly around the smaller cross-sections, so that they are artificially increased. In that way it is possible to heat equally through a cross-section situated anywhere by leaving this section free and moulding dielectric substance round the other parts of the object. This produces a localised heating of the whole section, for example, an elbow or a knee.

The greatest difficulty in human application is the apparent necessity of electrodes of bigger size than the object. Not only is the relation of the size of the electrodes to the object important, but also the relation between the length of the object to its cross-sections. This can be corrected to a great extent by suitably shaped auxiliary electrodes. Recent experiments seem to show that it is sufficient if one electrode only is bigger ; and if one does not wish to reach a higher temperature in the centre than near the surface, then two small electrodes are sufficient for a practically equal heating.

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Jan. 16.

Well Gauges as Seismographs

A NUMBER of workers[1] have noted that distant earthquakes are registered on automatic water stage recorders operated on deep wells. In each of these cases, the time scale was so small that the earthquake record was merely a thick line transverse to the direction of time movement. We recently fixed a gauge in a well at Lodi, California, with a Bosch-Omori seismograph drum, rate 15 mm./min., and smoked paper recording. The well is known as 3612A2. It is located at lat. 38° 07′ 38″ N., long. 121° 16′ 29″ W. in the Mokelumne area of the San Joaquin Valley. It is of circular cross section, diameter 6 in., depth 76·0 ft. below ground surface which is at an altitude of 46·9 ft. above mean sea-level. This well, which is not cased below the water surface, is in unconsolidated alluvial deposits of

Pleistocene and Pliocene age. It presumably penetrates to a confined aquifer or aquifers. No log is available. The gauge is composed of a copper float, $4\frac{1}{2}$ in. in diameter, which operates a stationary 8 in. float-wheel by means of a cord and counterweight. A 4-in. diameter axle mounted on the float-wheel shaft is connected at its upper periphery by a copper ribbon to an auxiliary wheel in the same plane and at the same elevation, on the other side of the recording drum, tension in the ribbon being maintained by a second counterweight below the auxiliary wheel. An aluminium stylus attached to the copper ribbon thus moves horizontally a distance equal to one half that which the float moves vertically. This stylus records on smoked paper on the drum. The minutes are marked on the record by means of a pendulum contact-making clock (supplied by Spindler and Hoyer with Bosch-Omori seismographs), actuating a relay circuit coupled to a solenoid, which energises the magnetic counterweight. Thus the stylus is displaced each minute. The clock correction is obtained daily.

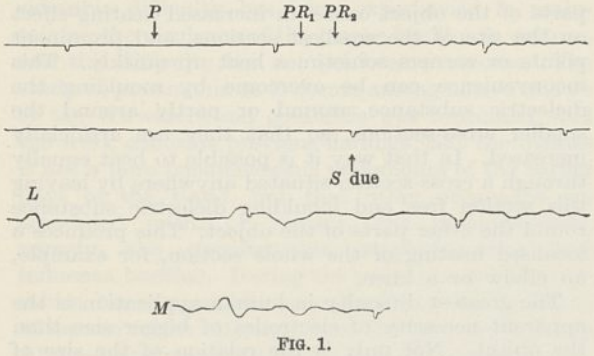

FIG. 1.

On November 30, 1934, at about 2h 05m 12s, G.M.T., an earthquake occurred with epicentre at 18·5° N., 105° W., as placed by the Jesuit Seismological Association. This was the first shock to be well recorded on the Lodi well gauge. The record is reproduced in Fig. 1. The epicentral distance of Lodi was about 25°. The *P* phases were all recorded, the reflections PR_1 and PR_2 particularly well. The *S* waves were not distinguishable. At the Berkeley station (epicentral distance 25°) the Bosch-Omori seismographs (static magnification 40) wrote an excellent record of this shock. The amplitudes of the *S* waves were about four times those of the *P* waves. Some workers have hesitated to say definitely that the second preliminary or *S* wave is a shear wave. It appears that its failure to record on the well-gauge establishes definitely that it is an equivoluminal wave, since it is to be expected that only waves involving change in volume, and hence hydrostatic pressure, will affect the water-level. More sensitive recording apparatus may eventually reveal some small motion when *S* is expected due to the surface reflection of some of the *S* energy as *P* waves.

The surface waves are well marked on the record. These begin with the wave tabulated as *L* by Macelwane in his table. It has been clear for some time that this wave is not a Love wave since it has usually a vertical component. The recording of it on a device not sensitive to shear waves confirms this. The Love wave is regularly recognised on seismograms much earlier and is now frequently called *G*. It appears possible to recognise a later group of waves resembling the *M* waves on many seismograms. Although not usually tabulated, there are three groups of seismic surface waves: *G* (Love waves), *L* and *M*. Only the latter two were recognised on the well record.

The appended table gives the observed and computed times of the various groups of waves. The maximum half amplitude on the record was 0·8 mm.

Phase	Observed Time	Computed Time
P	2h 10m 36s	2h 10m 37s
PR_1	11 16	11 10
PR_2	28	23
L	17 02	17·4
M	20 21	19·8

We wish to acknowledge the assistance given by Mr. Theodore Netland.

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Lodi.

[1] H. T. Stearns, Bull. 18, Seis. Soc. Amer., pp. 9–15, March, 1928; S. B. Morris, paper read before a meeting of Seismological Society of America, Los Angeles, April 8, 1933; A. M. Piper, *Trans. Amer. Geophys. Union*, April, 1933 meeting, pp. 471–475; R. M. Leggette and G. H. Taylor, *Earthquake Notes*, 6, pp. 16, 17, September, 1934.

Sedimentation Equilibrium Measurements with Low Molecular Substances in the Ultra-Centrifuge

IN a recent paper[1] I have shown that it is possible to study the sedimentation equilibrium of the heavier inorganic salts (for example, CsCl, CsI, KIO_3, $LiIO_3$, $HgCl_2$ and others in 0·1 molar solutions) in the ultra-centrifuge of The Svedberg[2]. These experiments were carried out in a centrifugal field of about 200,000 times gravity. By means of a refractometric method worked out by O. Lamm[3] it was possible to study the change in concentration in the cell. From the variation of the concentration set up by these intense centrifugal fields with the distance from the axis of rotation, the molecular weight of the substance may be calculated when the speed of the centrifuge and the temperature of the cell are known. In addition, it is necessary to know the density of the solution and the partial specific volume and activity coefficient of the substance in solutions of like concentrations.

The calculated molecular weights agreed fairly well with the known values for these substances except in the cases of the substance with the lowest molecular weight, CsCl, where the difference in concentration was very small.

Quite recently, Prof. Svedberg has greatly improved his ultra-centrifuge (see Svedberg, *loc. cit.*), and in October last a new rotor of a somewhat different construction from that already described in NATURE was tested at 155,000 r.p.m. and was ready for general work up to a speed of 140,000 r.p.m., corresponding to a centrifugal field of 710,000 times gravity in the middle of the cell. Although the cell for this rotor was not especially constructed for equilibrium experiments, it was decided to try to use it in this way with low molecular substances, at a speed of 120,000 r.p.m., corresponding to a centrifugal field of 525,000 times gravity. At once it became clear that the difficulties in such high fields were very much larger, because the cell was deformed continuously. However, it was possible to diminish

the influence of this deformation on the measurements by making alternate experiments with pure water (for the reference scale, for details see Pedersen, *loc. cit.*) and the salt solution. In this manner we are able to relate values for a certain run to the run immediately before and immediately after it (each run took 6–8 hours).

By using this procedure there could be measured the change in concentration in the cell for such low molecular weight substances as NaCl, LiCl and the simplest amino acid (glycocoll). The molecular weights found were: for NaCl 57·4 (58·454), for LiCl 37·8 (42·397) and for glycocoll 68·1 (75·05). The values in parenthesis give the true molecular weights. This result means that it is actually possible by means of the ultra-centrifuge to determine the molecular weight of all substances (soluble to a certain extent in water) from LiCl up to the huge hæmocyanine molecules (molecular weight 6,000,000).

The experimental difficulties connected with the gradual deformation of the cell we hope to be able to overcome by introducing certain alterations in its construction.

The calculations of these experiments were carried out in a somewhat different way from that used before[1], introducing the refractive index increment of the substance. Assuming that the same total amount of substance is present in solution in the cell when the equilibrium is established as at the start, it is possible by means of an integration method to determine the concentration of the substance at any point of the cell, and after this the molecular weight may be calculated either in the usual way or by introducing the value found for dc/dx in the differential formula for the molecular weight.

Details will be published elsewhere.

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Dec. 22.

[1] Kai O. Pedersen, *Z. phys. Chem.*, A, **170**, 41; 1934.
[2] The Svedberg, G. Boestad and I.-B. Eriksson-Quensel, NATURE, **134**, 98; 1934.
[3] Ole Lamm, *Z. phys. Chem.*, A, **138**, 313; 1928. **143**, 177; 1929.

Use of the Centrifuge in Determining the Density of Small Crystals

IN a previous letter[1] we described a method of determining the density of small crystals of a substance with the centrifuge for the purpose of determining its molecular weight. It has since been brought to our notice that essentially the same method has been used by S. B. Hendricks[2] though with a different object. We should, therefore, like to correct the impression that we claim any novelty for this method of density-determination, while still wishing to point out its usefulness as a method of determining molecular weights to a high degree of accuracy.

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D. CROWFOOT.

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[1] NATURE, **134**, 809; 1934.
[2] *J. Opt. Soc. Amer.*, **23**, 299; 1933.

Mechanism of Respiration

THE respiration of the minced breast muscle of the pigeon has been studied by means of specific poisons (malonic, maleic and arsenious acid). Experiments show that in the main process of respiration, no substances other than succinic acid and its first oxidation product, fumaric acid and the hydrate of the latter, malic acid, are oxidised directly by the Warburg-Keilin 'Atmungsferment-Cytochrom' system. Both succinic and malic acids are activated by the corresponding specific dehydrogenase. Only these two dehydrogenases seem to be connected immediately with the Warburg-Keilin system. Succinic acid is oxidised by them to fumaric, malic to hydroxy-fumaric acid. Both oxidations are reversible.

Foodstuffs are oxidised by dismutating them with oxidation products of succinic acid, which products thereby become re-reduced and act thus as catalytic hydrogen carriers. The 'oxidation system' is an enzyme complex acting specifically on succinic acid and its oxidation products. Fermentation is an intramolecular dismutation. Oxidation is dismutation with oxidised succinic acid.

This research has been sponsored by the Josiah Macy, Jr., Foundation, New York.

A. SZENT-GYÖRGYI.

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Jan. 26.

Cosmical Chemistry

MANY will read with interest and admiration Prof. H. N. Russell's fascinating and masterly address published as a supplement to NATURE of February 9; it is all that an address should be on such an occasion. Having watched the story of ultramundane chemistry unfold from all but its Bunsen and Kirchoff-Stokes beginning, especially during the turbulent Lockyer period, I perhaps can appreciate both its beauty and the greatness of our advance in knowledge more than most, so may be allowed to tender to Prof. Russell the thanks that so many, I am sure, will wish to express.

What would the founder and first editor of NATURE have said to the use made of the spectroscope since he turned his instrument to the sun and discovered helium, the only element discovered in the sun, perhaps some day, when we draw pictures of atomic structure as we now do of molecular, to be recognised as the fundamental element as benzene is the fundamental carbohydride? The wave of enthusiasm then excited has rolled on with ever increasing amplitude and certainty of direction.

The cosmos stands revealed before us, in wondrous simplicity too. Even organic chemistry is lifted up to the stars and shown to have the simplest possible beginning there in methane, together with ammonia. Some planets, it seems, may be worlds of Franklin chemistry; with ammonia as snow.

We are in face of a transcendent geology but whilst readers of NATURE may geologise on Mars and recognise ferric red on its surface rocks, few of our schools pay the least attention to mundane geology. Dust has no ethics in most eyes: our women wear it but without understanding. Love of colour is a barbaric trait—understanding is not. Are the masses ever to remain barbarians? What is to be the use of leisure in the future? At least, we should seek to civilise our politicians and all who strive to

put themselves in authority over us: the freedom to display ignorance granted to these, as at Wavertree these last few weeks, is nothing short of a menace to society.

Still, the physicians have to heal themselves. When, fifty years ago, I began to teach my engineering students at the 'Central' to look chalk in the face, in the hope of leading them to take some slight interest in geology, I had the beautifully coloured large Geological Survey map of our islands, made by joining the separate sheets, pasted upon the wall, on the stairway leading to the laboratory, varnished and framed; it was there until I left in 1914. I made the class buy the key map of the Survey and Charles Kingsley's lectures on "Town Geology", advising students to hang the map up in their bedrooms. Looking for the map at the jubilee celebration, at the 'Central', this week, I found the wall reduced to the condition of the map bought by the 'brave Captain' in "The Hunting of the Snark"—a perfect and absolute blank! Modern professors of engineering have no use for geology; their hearts are so encased in steel that they no longer see anything in stones. A like map has reigned at the head of the stairway to the large science workshops at Christ's Hospital since the school was opened at Horsham more than thirty years ago. I expect soon to see its place taken by School Certificates. Geology is only brought before us to-day by the saving grace of the railway poster.

HENRY E. ARMSTRONG.

Feb. 9.

Wasting Disease of *Zostera marina*

IN Dr. Kathleen B. Blackburn's letter on this subject[1], the conclusion seems well established, through a study of the chromosomes, that the narrow-leaved form of the eelgrass (grass wrack), which has in many of the diseased areas replaced the larger and broader type of plant, is clearly a form of *Z. marina* and not a hybrid of *Z. marina* and *Z. nana*, as some have believed. Miss Blackburn therefore suggests that the difference in the width of the leaves of varieties of *Z. marina* may be a purely ecological character. She further remarks that, in the localities examined, the width of the leaf of *Z. marina* was directly proportional to the depth of the water, and that the very narrow-leaved forms were those that had been longest exposed by the fall of the tide, while the broader were those that had not been exposed at all.

It may be of interest to report that on the American coast the evidence does not entirely support this ecological interpretation. *Zostera marina* is the only species recognised as occurring on this side of the Atlantic, and it extends from southern Labrador (with outlying stations in southern Greenland and in James Bay) southward to a point near the city of Beaufort, North Carolina. In travelling from north to south, one notices a gradual and progressive reduction in the size of the plant and in the width of the leaf blade. Leaves from plants found in northern Maine, for example, are often more than three times the width of those from Pamlico Sound, North Carolina. The diameter of the rhizomes likewise undergoes reduction southward, and there is an accompanying reduction in the number of leaf veins.

Dr. Setchell, in his excellent paper, "Morphological and Phenological Notes on *Zostera marina* L."[2], does not specifically state that the plants in their first year of growth are smaller and have narrower leaves than in the more mature stages, although he seems to demonstrate this in his illustration of stages in the growth of plants. From observation of *Z. marina* in places where it has begun to re-establish itself along the Atlantic coast from Maine to North Carolina, there is ample evidence of this habit of growth. In many such places the plant has shown some slight evidence of recovery, and wherever examined, the new growth has been found more slender than in the mature plants.

At a point on the coast of eastern Maine where the average tide fluctuation is nearly 18 ft., I found eelgrass growing in more than 10 ft. of water at mean low tide. The plants here were narrower than in those that appeared to be of the same age growing in shallower water. It does not seem, therefore, that the depth at which the plant grows always is positively correlated with breadth of leaf.

The observed characters of *Zostera marina* on the Atlantic coast of North America would seem to indicate that robustness is correlated with both temperature and age of the plant, the northern forms of a given age being larger and having broader leaves than those from farther south. Perhaps the length of the growing season may be an important factor in this regard. Setchell shows that vegetative growth of this species takes place when the water temperature is 10°–20° C., while reproduction occurs only between the temperatures of 15° and 20° C. According to the same author, no growth or reproduction takes place when the temperature is either above or below these limits or during the period when the temperature is declining from 20° to 10° C., which he calls recrudescent rigor. Thus, there is a shorter growing season in extreme southern latitudes than in most of the northern areas of the plant's normal range.

Among local factors that frequently influence the development of submerged aquatics may be mentioned water currents, temperature, the condition of the bottom, particularly in regard to type and texture of soil, and the chemical composition of the water, especially in relation to fluctuation of salinity of tide water sections of coastal river systems. My own observations seem to show that the general vigour of *Zostera marina* is lessened in areas of greatly reduced salinity, and that at such places the leaf is comparatively narrow. The above and other factors are to be considered in any interpretation of the causes of abnormal leaf development.

It is conceivable that, in some circumstances, as in British waters, the plants might be stimulated by depth to produce broad leaves, yet this does not seem to be typical of conditions on the American coast.

CLARENCE COTTAM.

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Dec. 21.

[1] NATURE, **134**, 738; 1934.
[2] *Univ. Calif. Publ. Bot.*, **14**, No. 19, 389–452; 1929.

Germination of Resting Spores of Onion Mildew (*Peronospora Schleideni*)

IN spite of the ubiquity of the Peronosporas and the frequent occurrence of sexually produced spores amongst the various species, very little is known in regard to the ultimate fate and method of germination of such oospores. Several workers have recently commented on this fact.

In a previous publication[1] attention was directed to the failure to germinate resting spores of *Peronospora Schleideni* in the laboratory, even when subjected to different treatments. The peculiar germination of one untreated spore, kept in a sealed moist chamber for several months, was mentioned in the same paper. Since then, the germination of a number of resting spores of this fungus has been seen under more natural conditions.

In the year 1930, I found a crop of onions in which enormous numbers of resting spores of onion mildew were being produced in the foliage. A sack-full of these leaves was collected and taken home, being then trampled into a large box provided with holes at the bottom for drainage. Bacterial action soon commenced and the leaves went down into a vile-smelling mess, which after the lapse of a few weeks dried up, leaving a fine material a couple of inches deep in the box consisting of decayed leaf tissue and abundance of resting spores. The box has remained fully exposed in a garden since then, and periodically, a little of the fine material has been removed in order to photograph any change occurring in the spores, and also to test for germination. The collapsed oogonium is remarkably persistent, and forms an additional protective layer 2–3μ in thickness around the thick spore wall.

Little or no change was seen in the spores until they were three years old, when it was found that in some cases the oogonium had disappeared wholly or in part, and the spore wall had thinned down to 2–1μ. Germination of an odd spore was obtained at the end of four years, and after a further five months, on placing some of the material from the box in water in a warm room, approximately 1 per cent of the spores germinated after eleven days, a total of twenty-seven being observed. Germination in all cases was by a stout germ-tube 6–9μ in diameter, which was capable of considerable growth in water, up to 960μ. In a number of cases this germ-tube branched. Spores which were partly free from the oogonium and germinated were of a light straw colour; in some instances the germ-tube pushed its way out through the enveloping folds of the persistent oogonium. Whilst thinning of the spore wall has taken place in quite a considerable number of the spores, others show no visible change from those photographed at the end of the first year, and judging from their appearance they are probably good for another five years.

So far as I am aware, the above is the only record of the germination of resting spores of onion mildew.

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Drumcondra,
Dublin.
Jan. 15.

ROBERT MCKAY.

[1] Murphy, Paul A., and McKay, Robert, *J. Dept. Lands and Agric. Dublin*, **31**, 59–76; 1932.

Crystallisation of Human Serum Albumin

APART from Oswald's report[1] that he had obtained globuliths from the albumin fraction of human ascitic fluid, we have been unable to find any account of the crystallisation of human serum albumin. Recently we have succeeded in obtaining albumin crystals from two separate batches of pooled human sera.

Serum was separated from the clot, heated for 25 minutes at 56° C. and fractionated within two or three days of bleeding. After addition of an equal volume of saturated ammonium sulphate and removal of the globulin, crystallisation was brought about by adding normal acetic acid. The requisite amount was first determined for 5 c.c. portions, acid being added from a micro-burette until the first faint permanent turbidity was observed; about 0·21 c.c. were required. Whereas crystals of horse serum albumin usually appear within two hours of acidification under these conditions, we were unable to detect crystals in our preparations of human albumin before the following day. Our experience has indicated that crystallisation of human albumin takes place within narrower limits of hydrogen ion concentration than is the case with horse serum albumin.

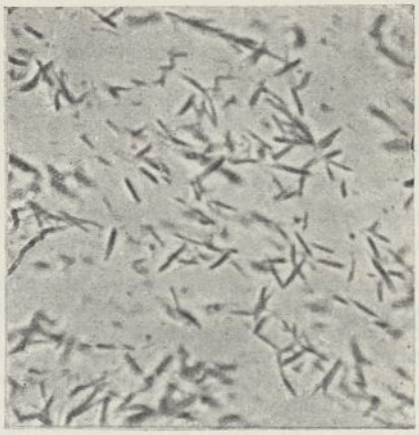

FIG. 1. Crystals of human serum albumin. ×540.

The main bulk of the protein solution was treated by adding slowly the calculated amount of acetic acid. After well-defined crystals had formed, the yield was increased by addition of a further amount of acid—half the volume of that first used. Two or three hours later a third addition of acid, equal to the second quantity, was made. The following day the crystals were collected by filtration.

The crystals obtained were readily visible under the 1/6 power of the microscope as small fine needles (Fig. 1). As in the case of horse serum albumin, the crystals dissolved in water to give an opalescent solution which was clarified by filtration, the turbidity being apparently due to lipid associated with the protein.

5 gm. of crystalline albumin was obtained from 300 c.c. of serum, representing a yield of about 40 per cent of its albumin content. Recrystallisation can be brought about by the method described by Adair and Robinson[2].

MURIEL E. ADAIR.
G. L. TAYLOR.

Department of Pathology,
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Jan. 8.

[1] *Z. physiol. Chem.*, **95**, 102; 1915.
[2] *Biochem. J.*, **24**, 993; 1930.

Stability of the Acetyl Radical

IT is usually supposed that free acyl radicals do not survive the shock of thermal or photo-dissociation of the molecule from which they might be formed or, if formed, decompose further before they can react with other molecules to give rise to isolable products. Thus Rice has shown that no diacetyl results from the thermal decomposition of acetaldehyde[1], and Norrish has concluded as a result of his studies of

the decomposition of aldehydes and ketones that both of the bonds between the carbonyl group and the two groups attached to it are broken practically simultaneously, the two groups then, in general, uniting to form a saturated paraffin[2].

During an investigation of the photo-decomposition of di-ethyl-peroxide, we have found that the chief products are ethyl alcohol and a greenish-yellow substance which has been finally determined to be diacetyl. Little if any acetaldehyde was produced, at any rate during the early stages of the decomposition. The decomposition was very slow, and although no measurements of the quantum yield have been attempted, a chain reaction would seem improbable.

The formation of ethyl alcohol and diacetyl can be accounted for by a mechanism based on that of Haber and Willstätter[3] for enzyme oxidations and also employed by Taylor and Gould to explain the oxidation of ethyl alcohol photo-sensitised by hydrogen peroxide[4]:

$$CH_3.CH_2-O-O-CH_2CH_3+h\nu \rightarrow 2CH_3.CH_2.O-$$

$$CH_3.CH_2.O- + CH_3CH_2-O-O-CH_2CH_3 \rightarrow 2C_2H_5OH+CH_3\dot{C}O$$

$$2CH_3\dot{C}O \rightarrow (CH_3CO)_2.$$

Such a mechanism necessitates a somewhat long-lived acetyl radical. In order to obtain further evidence for this, we have examined the non-gaseous products of the decomposition of the three simplest ketones and acetaldehyde. In all cases the products were of a greenish-yellow colour, which was, however, only faint with diethyl-ketone and acetaldehyde.

The products from acetone and methylethyl-ketone yielded with dinitro-phenylhydrazine a few milligrams of a substance almost insoluble in boiling alcohol (and therefore readily separable from the ketone derivative) but which could be recrystallised from pyridine. A derivative with similar solubilities was also obtained from the acetone product with mono-nitro-phenylhydrazine. In all cases the physical properties of these derivatives agreed with those of the corresponding derivative of diacetyl. Damon and Daniels have also observed that the liquid products from the photo-decomposition of acetone are coloured.

While far from being conclusive, this evidence would seem strongly to suggest that the acetyl radical is much more stable than is usually assumed, and that it possibly plays a significant rôle in the photo-decomposition of acetaldehyde and acetone at room temperature.

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[1] F. O. Rice, *Trans. Far. Soc.*, **30**, 168; 1934.
[2] Kirkbride and Norrish, idem., **27**, 407; 1931.
[3] Haber and Willstätter, *Ber.*, **64**, 2844; 1931.
[4] Taylor and Gould, *J. Phys. Chem.*, **37**, 367; 1933.
[5] Damon and Daniels, *J. Am. Chem. Soc.*, **55**, 2370; 1933.

Diffusion of Gases through Metals

I HAVE read with interest the letter by Dr. Smithells and Mr. Ransley on the diffusion of gases through metals in NATURE of November 24. I agree with them that diffusion is dependent on the solubility of gases in metals, and that the approximate proportionality to $\sqrt{P}$ is related to the fact that sorbed hydrogen is not only monatomic, but also ionised, as pointed out by me[1] and by A. Coehn[2]. Further, adsorption on the surface must be distinct from absorption within the metal. Absorption must be considered in the study of diffusion, just as Fourier and Poisson took account of specific heat in their classical equations for thermal conductivity.

In occlusion and diffusion, the hydrogen is in the form of protons (or deutons). I think the condensation of molecules on the metal surface, due to electrostatic attraction, produces electronic perturbations in the surface metal atoms (as shown by the effect on the photo-electric properties), which facilitates the diffusion of the gas. The effect of the adsorbed film can therefore only extend to a distance of one atomic diameter, and the mobility of protons within the metal will not depend on adsorption, but on the particular atomic arrangement of the metal and on the concentration gradient of absorbed hydrogen.

An equilibrium exists between the adsorbed gas and the gas absorbed near the surface, in which the two concentrations have a fixed ratio for each gas-metal system. Diffusion therefore depends on many factors. The proportionality between diffusion and $\sqrt{P}$ can be readily interpreted theoretically. The deviation from this law can be tentatively explained either by assuming an adsorption pressure threshold on one side and an evaporation pressure threshold on the other side of the metal; or alternatively, as suggested by Smithells and Ransley. The hypothesis can be tested by considering the behaviour of palladium towards hydrogen and deuterium.

From experiments which are still proceeding and will be published elsewhere, I have been able to show that palladium adsorbs deuterium very considerably from a mixture of hydrogen and deuterium, whereas it is well known that deuterium diffuses very slowly, in comparison with hydrogen, through palladium.

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R. Università,
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Dec. 15.

[1] T. Franzini, *Rend. R. Ist. Lomb.*, 709; 1931. *N. Cim.*, No. 9; 1931.
[2] A. Coehn, *Z. Phys.*, **62**, 1; 1930. **71**, 79; 1931. **83**, 291; 1933.

Molecular Spectrum of Cadmium Vapour

IN a recent article on the above subject, S. Winston Cram[1] has reported his inability to obtain, either in fluorescence or by excitation with a Tesla coil, a narrow diffuse cadmium band at 2212. He concludes that the band in that region which I obtained some years ago[2], using a pure electrodeless discharge in low pressure vapour, must be due to an impurity.

During a year's leave of absence, when working in the astrophysics laboratory of the Imperial College of Science and Technology, I made a careful examination of the molecular spectrum of cadmium. Although a full account of this work will be published later, in this letter I should like to direct attention to the following results relating to the origin of the band in question.

(1) As is shown by the spectra reproduced in Fig. 1, an arc between cadmium electrodes emits a band at 2212 with an intensity greater than that of the emission band at 2125. This was first noticed in a few cadmium plates given me by H. G. Howell, of Armstrong College, Newcastle-on-Tyne. On trying

an arc myself, it was found that with exposures of the order of one or two seconds, the 2212 band appeared with marked intensity.

(2) With a high-frequency (valve) circuit and external electrodes applied to a tube containing cadmium vapour at pressures ranging from 10 mm. to 40 mm. or higher, the narrow isolated band at 2212 was not obtained. In agreement with Cram's results, it was found that the continuous emission on the short wave-length side of the resonance line 2288 extended as far as a sharp edge in the neighbourhood of 2212. In two or three spectrograms, however, an increased intensity near 2212 gave the appearance of a narrow band at that place.

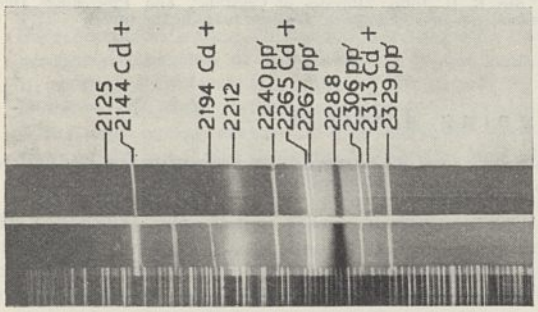

FIG. 1. Arc spectra of cadmium, with copper arc superimposed on the lower spectrum.

(3) In the case of zinc vapour excited with the same high-frequency arrangement, an emission band at 2000 was obtained without difficulty at pressures of the order of 10–12 mm., as is clearly shown in Fig. 2. This fact is not irrelevant to the origin of the 2212 cadmium band, because zinc and cadmium have corresponding absorption bands—at approximately 2064 and 2002 for zinc; 2212 and 2125 for cadmium. In a note in the *Physical Review*, Winans[3] has stated that the 2212 cadmium and the 2064 zinc bands, both present in absorption, are both *absent* in emission.

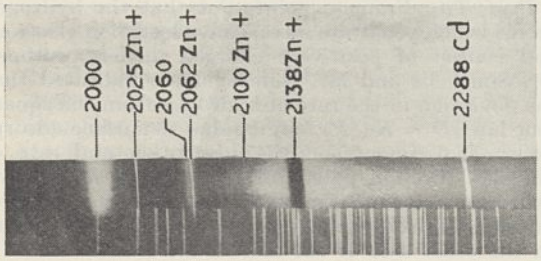

FIG. 2. Spectrum of zinc vapour when excited by high-frequency discharge, with external electrodes. Copper arc superimposed.

Although my observations as given in paragraph (2) might readily be used in support of Cram's view that the 2212 band is an impurity, it seems to me that the weight of the evidence is in favour of its being a true cadmium band. In support of this position, I submit the following arguments.

(*a*) The undoubted presence of 2212 as an emission band in the arc makes it less probable that its appearance, under certain conditions, in an excited tube, is due to an impurity. It is not without significance that in both the arc and the early electrodeless discharge showing this band, *pp'* lines are present with considerable intensity. These do not occur in Cram's spectra (nor in my recent high-frequency discharges), and it may be that the presence of a narrow band at 2212 is associated with the excitation of this group of lines.

(*b*) The undoubted presence of a band in both emission and absorption, in the related element zinc, strongly suggests the probability that the corresponding band in cadmium should also be present in emission, as well as in absorption.

(*c*) Since there is without question an absorption 2212 cadmium band, it is not a matter of surprise that there should be an emission band also. Of course, this does not necessarily follow, but the presence of an absorption band does help to make it less likely that an emission band, found in the same place, is due to an impurity.

The origin of certain diffuse bands which occur in the spectra of metallic vapours is, however, not always easy to settle. It is only through the co-operation and continued experiment of different workers, using different conditions, that certainty can finally be reached.

J. K. ROBERTSON.

Queen's University,
Kingston, Canada.
Dec. 11.

[1] Cram, *Phys. Rev.*, **46**, 205; 1934.
[2] Robertson, *Phil. Mag.*, **14**, 795; 1932.
[3] Winans, *Phys. Rev.*, **37**, 902; 1931.

Structure of Br III

THE spark spectrum of bromine, excited under different conditions, has been photographed over the wave-length range λ450–7000, using various instruments, and lines belonging to the doubly ionised atom have been identified.

These experiments have made possible the detection of the structure of Br III, which is found in all its characteristic features to be analogous to that of Se II, classified recently by us[1]. The intervals of the fundamental term $5s\ ^4P$ are 2587 and 2253 cm.$^{-1}$; and those of $5p\ ^4D$ are 2413, 2070 and 658 units. This scheme is, however, at variance with the one published by Deb[2], which, we consider, is improbable in many important respects. A complete report of the new classifications will be published shortly.

K. R. RAO.
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Jan. 16.

[1] *Proc. Roy. Soc.* (in press).
[2] *ibid.*, A, **127**, 204; 1930.

Large Sunspot Group of February 1935

ALTHOUGH the sunspot group referred to in NATURE of February 16 (p. 260) was not specially large, it was of interest because of its very rapid growth. Spectroheliograms in $K_{2,3,2}$ light were secured through thin cloud at the Solar Physics Observatory, Cambridge, on February 5, 6 and 7. On February 5 the group is shown on a plate exposed from $12^h\ 25^m\ 18^s$ to $12^h\ 26^m\ 51^s$, and as the formation was near the centre of the disc, it must have been recorded very near $12^h\ 26^m\ 5^s$. As no spot was shown on the Greenwich photograph

at 10^h, this fixes the time of formation of the spot to within $2\frac{1}{2}$ hours. On the spectroheliogram the feature was very small. On February 6 there is evidence of very rapid growth ; preceding and following spots are clearly shown, and the group extended over about 10° of solar longitude. February 7 still further expansion was shown, with an extent of flocculus of about 15° longitude. Any other observations of this spot group on February 5 during the hours 10^h to 12^h 30^m would be welcome as affording information of the details of development.

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Feb. 16.

Plasticity of Rock Salt Crystals

THE plasticity of rock salt crystals when immersed in water has been the subject of much attention recently[1]. The fact that the effect takes place more easily in hot water suggests that the rate of solution of the surface is a factor. I have therefore tried bending small plates of rock salt under running cold water from a large tap, and have found that the plasticity is surprising. Under these conditions it is quite easy to make a right angle bend in a plate of rock salt more than a millimetre thick in a matter of seconds.

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University College, London.

[1] See E. G. Joffe, "Physics of Crystals", and *Proceedings International Congress of Physics, London*, 1934 (in the press).

Points from Foregoing Letters

HIGH-FREQUENCY radio waves such as are used in television (3–20 m. in length), can increase the temperature of certain solutions and of living tissues, and have been used in medical practice (diathermic treatment). Dr. Franz Nagelschmidt describes a method of directing and localising the heating effect by interposing dielectric substances (wax, ebonite) between the electrodes and object, and gives suggestions for practical applications.

Automatic recorders of water-level in deep wells register earthquake shocks. Prof. Perry Byerly and Mr. Francis B. Blanchard describe a water-level recording instrument, and compare its record of an earthquake with that obtained by the usual type of seismograph. They point out that both the primary tremors (P) due to compressional waves travelling through the earth's interior and the later undulations (L) due to compressional waves travelling along the earth's surface were recorded by the water instrument. The intermediate vibrations (S) travelling through the earth's interior and the Love waves were not recorded. This confirms the view that both these latter are shear waves and do not produce changes in volume, which alone affect the water-level.

By means of an improved Svedberg ultra-centrifuge rotating 120,000 times per minute and giving a force of 525,000 times that of gravity, Dr. Kai O. Pedersen has succeeded in bringing about changes in the concentration of solutions of substances of low molecular weight. From these concentration changes, deduced from the changes in optical refraction, the molecular weights have been calculated ; they agree fairly well with the known values.

Prof. A. Szent-Györgyi in a succinct note states that in the main respiratory process of the muscle, the oxidisation of foodstuffs (or their loss of hydrogen) is brought about by oxidised products of succinic acid ; these carry away the hydrogen in the presence of certain enzymes (dehydrogenases).

Mr. Clarence Cottam agrees with Dr. Kathleen Blackburn that the narrow-leaved form of the eel grass is not a hybrid but a different form of *Zostera marina*. From observations on the Atlantic coast from Maine to North Carolina, he concludes that the variation cannot be accounted for simply as due to the depth at which the plant grows, but that other factors such as the age of the plant, temperature, salinity, water currents and conditions of soil or rock bottom may affect the width of the leaves.

The conditions under which the spores of the onion mildew germinate are insufficiently known. Mr. R. McKay has kept the spores under observation for several years, and finds that at the end of three years about one per cent of the spores have their cell-wall sufficiently thinned for them to germinate in water in a warm room ; the others are still good for another five years' resting stage.

Dr. Muriel E. Adair and Mr. G. L. Taylor have succeeded in obtaining for the first time microscopic crystals of the albumin from human serum (from dropsical patients).

Mr. M. Barak and Dr. D. W. G. Style have obtained diacetyl and its derivatives by means of chemical reactions which suggest that the acetyl radical, CH_3CO- is much more stable than usually assumed. They believe that this radical may possibly be an intermediate product in the photo-decomposition of acetaldehyde and acetone at room temperature, and in other important chemical reactions.

Prof. Tito Franzini points out that the hydrogen atoms which penetrate metals have lost their electrons and consist of positively charged nuclei (protons). Dr. Smithells and Mr. Ransley have indicated that the deviation in the rate of hydrogen from the square root law ($D = K\sqrt{P}$) may be due to surface adsorption. Experiments on the adsorption and rate of diffusion through palladium of ordinary and heavy hydrogen lead Prof. Franzini to assume an adsorption threshold on one side and an evaporation pressure on the other side of the metal.

S. W. Cram, not being able to confirm the observations of Prof. J. K. Robertson that cadmium vapour emits a band of ultra-violet light (wave-lengths around 2212 A.), when excited by an electrodeless discharge, has suggested that Robertson's observations may have been due to an impurity. Prof. Robertson repeated the experiment and obtained only traces of the band in certain spectrograms. He still believes, however, that cadmium emits such a band of light of wave-length 2212 A., and he submits spectrograms to show that it occurs in the arc spectrum of cadmium. Cadmium vapour absorbs light of this wave-length and it is probable therefore that it also emits it.

Research Items

Dual Organisation in Assam. A study of social organisation in Assam by Mr. J. K. Bose (*J. Dept. Letters, Calcutta University*, **25**) is based in part on a review of existing literature, in part on the results of field-work in the period 1931–34 among the Anals, the Aimols, the Lamgangs, the Mantaks, the Marrings and the Memis. It is thought that the dual organisation may throw light on the origin of the caste system. Among the Aimols, a very primitive tribe, there are two moieties, one superior and the other inferior, each having two phratries and each phratry two patrilineal clans; but the system is in process of disintegration owing to decreasing numbers and the scattered situation of the villages. Hence restriction in marriage is slackened; but in social and religious matters the dual organisation is strictly observed. Thus the social status of the superior moiety is recognised in all the important offices in the villages. The headman, assistant headman and priest all come from the superior moiety. The two moieties are also apart in the festivals they observe. The Anals, primitive hunter-agriculturists spread over sixteen villages in Manipur, have a typical dual organisation, while the Mantaks, a dwindling group, though in process of disintegration, retain a superior and an inferior moiety, but inferior officers are now drawn from the inferior moiety. The Lamgangs, a remote hill-people, show two moieties with only four clans each. Here there is evidence of the tendency to arrange the superior moiety in a hierarchy. Among the Marrings the dual organisation is of unique type, being based on territorial distribution. The Marring villages are grouped into a set of seven and a second set of five. This grouping has taken over the marital functions of the kinship groupings. It is clear that in Assam there are definite forms of dual or tripartite organisation of various types and in various stages of disintegration. Assam is, therefore, likely to prove as interesting for the study of early stages of society as Australia or Melanesia.

Reproduction in Nudibranchs. Mr. Leslie A. Chambers has made a valuable contribution to our knowledge of the methods of fertilisation and egg-laying in the Nudibranchiates (*Bull. Amer. Mus. Nat. Hist.*, **66**, 1934). The forms of the genital ducts are divided into four main types, and taking *Embletonia fuscata* as a typical nudibranch, the author describes the anatomy and histology of its reproductive system. There are three passages arising from the hermaphrodite duct—male, female and androgynous. A three-way valve effecting the selective separation of the spermatozoa from the ova is a feature hitherto undescribed, the author suggesting that it may have a possible general application to the hermaphrodite gastropods in which a separation occurs, that is to say, in most tectibranchs and all nudibranchs. There is also a mechanism for erecting the penis which seems to be peculiar to *Embletonia*. *Embletonia* was found in enormous numbers on the piles of a bridge near Beach Haven, N.J., all the individuals depositing spawn. In a few weeks they had all disappeared. This is typical of many nudibranchs, but as some species may be found breeding in the open sea as well as near the shore, it is suggested by the author that inshore spawning grounds are not essential, and that the large numbers of one species sometimes found spawning inland are due to the chance displacement and survival of a few individuals, and their rapid development, no migration taking place. Anatomical evidence is given that each individual may pass through repeated reproductive cycles in the same season. With so many broods and with every individual of each brood depositing numbers of spawn masses, each single mass containing several hundred ova, there is considerable possibility of deriving the presumed migrations from a single individual cast on the shore by chance.

***Calanus* Production in Norway.** Mr. Jacob D. Sømme has thoroughly investigated the biology of two species of *Calanus* (*finmarchicus* and *hyperboreus*) based on experimental studies and analyses of samples from the coast of Norway in various seasons (*Fiskeridirektoratets Skrifter. Serie Havundersøkelser*, **4**, 9; 1934). Both species winter in the Lofoten area at great depths. *C. hyperboreus* particularly is restricted in winter to the inner parts which are very deep, *C. finmarchicus* being not so sharply defined in its distribution. In spring a vertical migration takes place, and later both species are carried away over the coastal banks in the surface currents. The spawning area of *C. hyperboreus* is very restricted and mainly dependent upon the extent of the winter area of distribution, the development of the later stages probably depending on low temperatures. *C. finmarchicus* has a much longer period of spawning and a much larger spawning area. Both species may be found together. Tables for the identification of all stages are given, and it is shown that the larvæ of the two species are not distinguishable by morphological characters, but by measurement of the carapace rather than total length. Unfortunately, the paper by Dr. S. G. Gibbons on *Calanus finmarchicus* (Fisheries, Scotland, Sci. Invest., 1933. No. 1) was published too late for it to be used, as was also Dr. Nicholls's study of the life-history of *Euchaeta* (*Proc. Roy. Soc. Edinburgh*, 1934).

'Plaster Mould' Diseases of Mushroom Beds. A very useful article by Mr. W. M. Ware appears in the *Gardeners' Chronicle* of December 22 and 29, 1934. It describes two 'weed' fungi which are likely to grow on mushroom beds, to the detriment of the edible fungi. Both of the undesirable organisms are known as 'plaster moulds', since they produce a white, powdery covering similar to a dusting of plaster or lime. The white plaster mould (*Oospora fimicola* = *Monilia fimicola*) was known by English growers some time before it was recorded by the mycologist. It also occurs in France and the United States. Characters of the species are given in detail, and its occurrence described. It appears on beds just before they are ready for spawning, and also grows upon the covering of soil or 'casing', which is applied after the spawn has been added. Circumstantial evidence indicates that the fungus is introduced by the manure. The brown plaster mould (*Papulaspora byssina* or *Myriococcum præcox*) originally made its appearance in the United States in 1923, but has now appeared in Great Britain. This disease appears at the same time, and under similar conditions to the white plaster mould, but is not usually so harmful.

It first produces a white superficial mycelium, which quickly becomes cinnamon brown except at the edges. The brown part bears 'bulbils', or aggregations of hyphal cells, which seem to function as the sole reproductive bodies of the fungus. The brown plaster mould also seems to be introduced by the manure.

Traps of the Bladderworts. It is refreshing to find a genus of plants, the bladderworts (*Utricularia*), which scores so admirably off the animal kingdom. Prof. F. E. Lloyd (*Biol. Rev.*, **10**, 1, 72; 1935) gives an extremely interesting account of the various kinds of traps—really modified leaves—and especially of the entrance mechanisms. The swiftness of the action is remarkable. By making use of motion photomicrography speeded up to 160 frames per second, the whole action falls within the sequence of five frames, the opening phase falling between two frames and the slower closing phase occupying the rest of the time. The entrance mechanisms of the traps are shown to be far more complicated and more delicate in their adjustments than has heretofore been thought, and are shown to be purely mechanical in action.

Clean-up of Gases by Getters. The process of removal of gas by the action of electropositive metals such as magnesium and barium is of great technical interest since it is much used in the evacuation of vacuum devices. A. L. Reimann (*Phil. Mag.*, Dec. 1934) has investigated the process for the 'getters' magnesium, calcium and barium and a number of common gases. Some clean-up occurs when the 'getter' is first volatilised on to the walls of the vacuum vessel (dispersal gettering); there is then some absorption of gas by contact action and the rate of removal is accelerated by maintaining an electric discharge in the gas. The 'dispersal gettering' may be treated as 'contact gettering' by a series of freshly formed getter surfaces. The contact gettering is more effective with barium than with magnesium or calcium, and is greatest when a black deposit of finely divided barium was formed by dispersal in the presence of gas. In most cases of contact gettering, the getter can take up much more gas than would cover its surface with a monomolecular layer—the gas seems to diffuse into the interior of the deposit. The gettering is usually favoured by a rise in temperature. The gas absorbed by a getter may be liberated again by heating, by displacement by another gas, or by impinging electrons or ions. In one of the experiments on a valve, if the anode potential was applied before the filament was heated, the getter acquired a positive potential and the vacuum deteriorated by electron bombardment of the getter. If the filament was heated and anode potential then gradually increased, the floating getter deposit acquired a different, lower, stable potential and the vacuum began to improve by clean-up. In electric discharge gettering, the getter removes particles such as positive ions and metastable molecules, and in some cases these form chemical compounds which are more stable than the products of simple contact gettering.

Oxygen Isotopes in Meteorites. An investigation on the relative abundance of the oxygen isotopes O^{16} and O^{18} in stony meteorites (S. H. Manian, H. C. Urey and W. Bleakney, *J. Amer. Chem. Soc.*, **56**, 2601; 1934) by a method involving the conversion of the combined oxygen to water and then, by electrolysis, to oxygen gas, showed that the specific gravity of the water indicated, within an experimental error of 29 per cent, in the ratio $O^{18} : O^{16}$, the same isotopic composition of the oxygen from three stony meteorites (Mocs, Knyahinya, Homestead) as from terrestrial granite and from potassium chlorate. Relative abundances of the isotopes in the oxygen gases were investigated by the vacuum mass-spectrograph and the same results were found, the experimental error in $O^{18} : O^{16}$ being reduced to $\pm$ 2·5 per cent. The value 514 $\pm$ 13·1 is submitted for the absolute abundance ratio $O^{16} : O^{18}$ for both terrestrial and meteoric oxygen. The agreement of this result with other mass-spectrographic determinations is compared, and the discrepancy with the band spectra value is pointed out. The average value of the mass-spectrographic determinations by the four different researches (omitting the results of Kallmann and Lasareff) is 517 $\pm$ 10.

The Methylene Radical. By the thermal decomposition of diazomethane carried in a current of ether or butane below 500°, the free methylene radical, $:CH_2$, appears. It removes mirrors of tellurium, selenium, antimony and arsenic from the tube. In the case of tellurium, a red solid polymer of telluroformaldehyde, $(HCHTe)_n$, is produced, whereas free methyl forms a volatile red liquid, dimethyl ditelluride, $CH_3TeTeCH_3$. F. O. Rice and A. L. Glasebrook, who report these results (*J. Amer. Chem. Soc.*, **56**, 2381; 1934), point out that they are not in agreement with current ideas on the nature of the methylene radical, most of which are based on Nef's premise that carbon compounds readily undergo a primary decomposition into a stable smaller molecule and a radical containing bivalent carbon, and some lines of evidence which would indicate that methylene should have a peculiar stability resembling that of a molecule rather than that of a free radical. At temperatures above 650°, it was found, but below the decomposition point of ether, only methyl groups were found; the methylene radical is apparently a highly reactive fragment of short life.

Meridian Observations of Faint Stars in Selected Areas. In the *Annalen van de Sterrewacht te Leiden*, **25**, 4, Dr. C. H. Hins publishes a general catalogue of positions and proper motions of 1190 standard stars in areas 2–115 of Kapteyn's plan of selected areas. This work is the reduction to a uniform system, and combination, of the work of five observatories taking part in Kapteyn's plan, namely, Leyden, Berlin Babelsberg, Bonn, Paris and Strasbourg. The positions are in every case modern meridian circle observations of right ascension and declination, and proper motions have been found by comparison with old observations: but it is found that the modern precision so much exceeds the old that better proper motions would be obtained by repeating the observations in a few years time than by combining new with old observations. The author has reduced all the observations to the Leyden system as fundamental. (This system is in full agreement in R.A., and in very close agreement in Dec., with the P.G.C. system.) The magnitudes of the stars lie for the most part between $7{\cdot}6^m$ and $9{\cdot}8^m$, the average magnitude being $8{\cdot}5^m$. The unit of weights is, on the average, $\pm$ $0{\cdot}0275^s$ sec δ and $\pm$ $0{\cdot}44''$ for R.A. and Dec. respectively, the weights attached to individual stars being for the most part from 2 to 10. Dr. Hins may be very heartily congratulated on the completion of this part of Kapteyn's plan of selected areas.

Effect of the Earth's Magnetic Field on Cosmic Rays in the Stratosphere

By MAX COSYNS, Physical Laboratory of the "Fondation Medicale Reine Elisabeth", Brussels.

DURING the last ascent of the balloon *F.N.R.S.* (August 18, 1934), we had the opportunity of measuring with precision the intensity of cosmic rays at altitudes of about 12,000 m., 15,000 m. and 16,000 m., by means of the ionisation chamber (Kolhörster type) which was used during our previous ascent with Prof. A. Piccard (August 18, 1932).

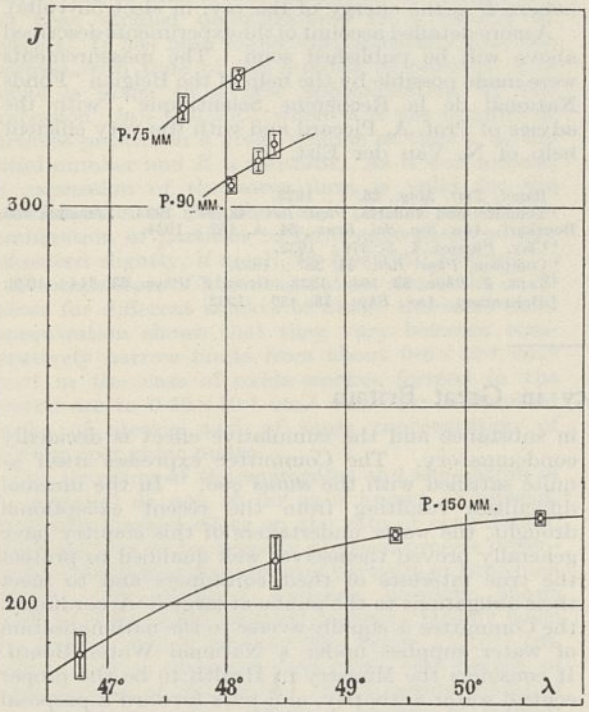

FIG. 1.

The comparison of these data, and also those of the previous ascent, shows clearly an effect of the earth's magnetic field.

From our sixty values of ionisation intensity (J), obtained at pressures of the atmosphere (P) ranging from 73 mm. to 170 mm. of mercury, and between 46° and 51° of north magnetic latitude (λ), we can deduce functions relating J to P, and J to λ (Figs. 1 and 2).

In Fig. 1, the circles give the mean values; the vertical lines give the probable error calculated from the dispersion of individual observations; the rectangles give the total probable error, calculated from the dispersion of individual readings, and from the precision of measurements of atmospheric pressure and geographical position. The atmospheric pressure was measured by means of two mercury barometers; the geographical position was determined by vertical photography with a Leica camera and infra-red films (precision = 30″) or by astronomical observations when the clouds below were too thick for photography (precision = 10′). The geomagnetic latitude was calculated taking 78° 30′ N. and 69° 8′ W. as the co-ordinates of the pole of the principal earth-magnetic doublet[1].

Through the four points of Fig. 1 which correspond to a pressure of 150 mm., we can draw a smooth curve; if we multiply the ordinates of that curve by reduction coefficients obtained from Fig. 2 (J vs. P), for pressures of 90 mm. and 75 mm., we obtain the two upper curves of Fig. 1, fitting the corresponding points within the probable error.

A comparison of these results with the theoretical curves of Lemaître and Vallarta[2] shows perfect agreement if we assume that more than 80 per cent of the ionisation in the stratosphere (for $\lambda > 50°$) is due to a charged corpuscular radiation of magnetic hardness $X_0 = 0{\cdot}30 \pm 0{\cdot}02$, and to the secondaries emitted by that radiation in the earth's atmosphere. Within the limit of experimental error, this is in perfect accordance with the results of Clay[3], who found $J = 12$ at $P = 150$ mm. and $\lambda = 18°$, and those of Clay and Compton[4], showing a maximum curvature of the (J vs. λ) curves for about $\lambda = 50°$, at pressures between 450 mm. and 760 mm.

The analysis of our (J vs. P) curve (at $\lambda = 48°$) (Fig. 2) by means of the Gross-Lenz method[5], gives a transformed curve $P\Psi_p = PJ_p - P^2 dJ_p/dP$, showing three maxima, corresponding to about 130 mm., 190 mm. and 400 mm. of mercury. Although their position is not defined with precision, the existence of the maxima seems to be beyond doubt, the amplitude of the corresponding variation of J being more than three times larger than the probable error.

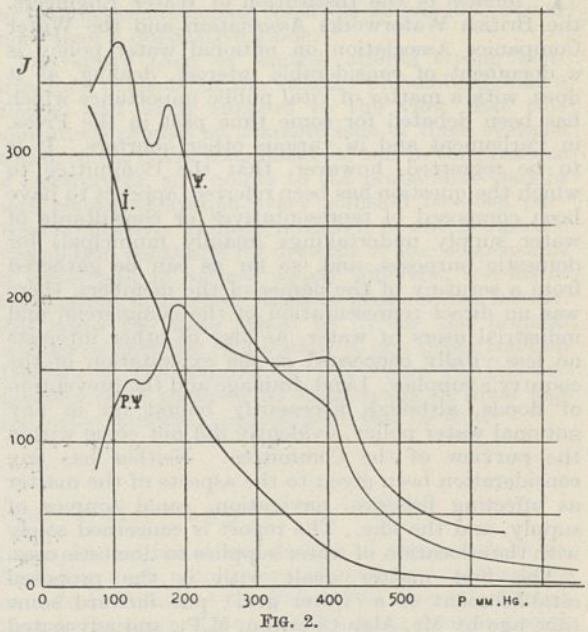

FIG. 2.

These three maxima show the existence of, at least, three soft components in the cosmic radiation, with ranges of the order of 130 mm., 190 mm. and 400 mm. of mercury. But, as the shape of the (J vs. λ) curve requires a very narrow range of magnetic hardness for the primary rays, only one of these components, if any, is a primary one.

To my idea, the hypothesis according best with the observed facts would admit a primary radiation consisting of two corpuscular components A and B, of respective magnetic hardness $X_{0A} = 0{\cdot}30$ and $X_{0B} = 0{\cdot}45$. The A component, positively charged, would give secondaries (electrons and positrons) of

discrete energy distribution, of which the hardest three components would have absorption coefficients of the order of 0·0018, 0·0039 and 0·0057 gm.$^{-1}$ cm.^{2}. The B component would give secondary radiations of the same nature as the secondaries issuing from A, with an energy distribution as yet unknown, but corresponding to an absorption coefficient of the order of 0·0027 gm.$^{-1}$ cm.^{2}.

The A and B components may perhaps be identified with Regener's components H_1 and H_2; their respective magnetic hardness X_0, calculated by the method proposed by Heisenberg[6], gives the right order of magnitude, if we assume that the primary rays are α-particles. If we suppose that X_{0A} is exactly equal to 0·30, we find $X_{0B} = 0·50$; this gives a good reproduction of Clay's curves (J vs. λ) at sea-level. However, Regener's values for the respective intensity of those components at the earth's surface are not in good agreement with our hypothesis. But it must be noted that the calculation of those intensities requires many assumptions about the secondary emission mechanism; it might be, therefore, that a new discussion of deep water measurements, with different assumptions, would give values more in accordance with magnetic effects.

Our hypothesis is also in quantitative agreement with the east-west asymmetry observed by H. Johnson and others. Quantitative divergences from those measurements may be attributed to the fact that we know little about the angular distribution of secondaries around the primary direction; and also to the fact that no account has been taken of the atmospheric electrical field effect. This effect is not negligible for the softer part of the radiation responsible for east-west asymmetry, as a calculation of a lower limit of the variation of the angle of incidence β of rays gives: $\Delta\tan\beta = \pm 515.E^{-1/2}$ (where E is the energy of the ray, in electron-volts).

A more detailed account of the experiments described above will be published soon. The measurements were made possible by the help of the Belgian "Fonds National de la Recherche Scientifique", with the advice of Prof. A. Piccard and with the very efficient help of N. Van der Elst.

[1] Bauer, *Terr. Mag.*, **28**, 1; 1923.
[2] Lemaître and Vallarta, *Phys. Rev.*, **43**, 87; 1933. Lemaître and Bouckart, *Ann. Soc. Sci. Brux.*, **54**, A, 162; 1934.
[3] Clay, *Physica*, **1**, 5, 376; 1933.
[4] Compton, *Phys. Rev.*, **43**, 387; 1933.
[5] Lenz, *Z. Phys.*, **83**, 194; 1933. Gross, *Z. Phys.*, **83**, 214; 1933.
[6] Heisenberg, *Ann. Phys.*, **13**, 430; 1932.

National Water Policy in Great Britain

THE recently issued report of the Joint Conference of the Institution of Water Engineers, the British Waterworks Association and the Water Companies Association on national water policy is a document of considerable interest, dealing, as it does, with a matter of vital public importance which has been debated for some time past in the Press, in Parliament and in various other quarters. It is to be regretted, however, that the Committee to which the question has been referred, appears to have been composed of representatives or consultants of water supply undertakings (mainly municipal) for domestic purposes, and, so far as can be gathered from a scrutiny of the names of the members, there was no direct representation of the commercial and industrial users of water, as also of other interests no less vitally concerned in the exploitation of the country's supplies. Land drainage and the prevention of floods, although necessarily bound up in any national water policy, evidently did not come within the purview of the Committee. Neither has any consideration been given to the aspects of the matter as affecting fisheries, navigation, canal sources of supply, and the like. The report is concerned solely with the allocation of water supplies to domestic uses.

The first matter dealt with is the proposed establishment of a 'water grid', put forward some time ago by Mr. Alan Chorlton, M.P., and advocated by him in a presidential address to the Institution of Mechanical Engineers in October 1933. This scheme, which is based on the analogy of the electricity grid, is condemned in the report in no uncertain terms. "We are definitely of opinion," states the Committee, "that as regards water supply, such a system is totally unjustifiable from every point of view, and especially in its economic aspect." The proposal is analysed in detail in a memorandum attached as an appendix to the report, summarising the objections under eight heads, which, for reasons of space, cannot be discussed here. Although, perhaps, controversial in some respects, they are weighty in substance and the cumulative effect is decidedly condemnatory. The Committee expresses itself as quite satisfied with the *status quo*. "In the unusual difficulties resulting from the recent exceptional drought, the water undertakers of this country have generally proved themselves well qualified to protect the true interests of their consumers and to meet their obligations to the public at large." Accordingly, the Committee is equally averse to the nationalisation of water supplies under a National Water Board. It considers the Ministry of Health to be the proper central water authority, and puts forward a proposal to meet the conditions at present prevailing by the "creation of a distinct, separate and specialised Water Department of the Ministry of Health", with various powers which are set out in detail.

It is perhaps not surprising that a Committee, constituted as stated above, should affirm its faith in the Ministry of Health as the sole suitable arbiter and dispenser of water throughout the country, but for the reasons already given, this can only be considered as a one-sided view. Other interests will scarcely be disposed to agree to such a monopoly. The British Association Research Committee on Inland Water Survey, whose investigations are referred to non-committedly, has been urging the establishment of a national survey of water supplies on a purely scientific basis under the Department of Scientific and Industrial Research. The Government, while acceding to the overwhelming demand for a survey, has seen fit to disregard this recommendation and to place the survey in the hands of the Ministry of Health. It is difficult to appreciate the grounds upon which this step has been taken, since no analogous example from the practice of other countries have been cited in support of it. That the Ministry of Health, the proper functions of which are clearly indicated in its designation, should intervene in other spheres where its action and control might be misguided and detrimental, is a matter greatly to be deprecated. BRYSSON CUNNINGHAM.

The Process of Coagulation in Smoke*

IN contradistinction to hydrosols, smokes are unstable systems. Their particles cohere when brought together by Brownian agitation, and this process of coagulation proceeds spontaneously until the system becomes a coarse suspension of complex aggregates, and finally sediments rapidly.

In recent years, special methods have been developed for counting the number of particles in many types of smoke, and the process of coagulation has been studied quantitatively in a variety of systems. It has been found experimentally that the decrease with time of the number of particles in a smoke is given to a first approximation by the expression $1/n - 1/n_0 = Kt$, where n is the number of particles present in a given volume at time t, n_0 the initial number and K a constant. As is well known, an expression of the same form is valid for the recombination of ions, but in a normal smoke the combination of particles to form aggregates is only influenced slightly, if at all, by electrical charges.

A comparison of the coagulation constants or K values for different smokes of about the same mass concentration shows that they vary between comparatively narrow limits from about $0{\cdot}8 \times 10^{-9}$ cm.^{3} sec.$^{-1}$ in the case of oxide smokes formed in the electric arc to $0{\cdot}50 \times 10^{-9}$ cm.^{3} sec.$^{-1}$ for a standard smoke of stearic acid of mass concentration of 15 mgm. per cubic metre.

The structure of the aggregates and the nature of the material do not, so far as is known at present, exert any marked effect on the rate of coagulation, which appears to be a purely physical process dependent on the chance encounter of particles in Brownian motion. Experimental evidence, however, shows that the coagulation constant increases rapidly when the average size of particle falls below 1×10^{-5} cm. radius, and it increases also with the degree of heterogeneity of the smoke. By a careful study of the conditions under which a smoke is formed, Patterson and Cawood have prepared disperse systems of stearic acid particles which initially approach to uniformity in size. This was accomplished by dispersing the heated solid in a rapid blast of hot air, and by this means diluting rapidly the concentrated smoke before coagulation had proceeded far. Such smokes are readily reproducible and form standard systems which coagulate at the same rate and contain the same number of particles, and since they form compact aggregates they approximate in character to ideal systems of spherical particles.

The well-known theory of von Smoluchowski, which has been confirmed experimentally for the coagulation of sols by the comprehensive researches of Tuorila, when modified so as to apply to aerial systems, enables the coagulation constant of a homogeneous smoke to be calculated from first principles. Patterson and Cawood have shown that when the experimental data for these 'blown smokes' are interpreted rightly, a remarkably close agreement between theory and experiment is obtained. Theory also indicates that whilst in sols undergoing quick coagulation the rate should be independent of size, in aerial systems it should increase as the particle size diminishes; a prediction in entire conformity with experiment.

Both in sols and aerosols, theory shows that heterogeneity must increase the chances of encounter between particles, but although in sols it has been possible to check experimentally the extension of von Smoluchowski's theory proposed by H. Müller, for heterogeneous smokes theory so far has not proved more than a qualitative guide.

The study then of smokes affords strong confirmatory evidence of the validity of Smoluchowski's theory, and lends support to the view that this continuous process so characteristic of these systems is akin to the quick coagulation of sols in the presence of electrolytes, and points to the probability that in both classes of system every collision between particles is effective. It must, however, be noted that the coagulation constants for systems of fine suspensions in water and in air are widely different, the latter being about a hundred times as great as the former. But since the time taken to reduce the original number of particles in a system to any given fraction depends on the number as well as on K, the disappearance of particles by coagulation in town fogs and other polluted atmospheres will be slow.

* Substance of the Liversidge Lecture delivered by Prof. R. Whytlaw-Gray, O.B.E., F.R.S., before the Chemical Society on February 14.

British Industries Fair, 1935

IN the account given last year in NATURE of the 1934 British Industries Fair, it was described as the largest national trade fair in the world. The 1935 Fair, which opened in London on February 18, is even larger than its immediate predecessor—a reflection, it may be hoped, of increasing prosperity in the nation's trade. At Olympia the lighter industries occupy every available square foot of exhibiting space, while the textile and furnishing sections at the White City are larger and more fully representative than ever. The main object of the Fair is, of course, a commercial one; the most welcome visitors are buyers. But the Fair has, undoubtedly, an educational value, for it presents to the visitor, in an attractive and accessible form and in a condensed space, a general survey of the results of the nation's manufacturing industry. Moreover, every changing phase in the tastes and habits of the people is reflected in such a collection of manufactured articles as is to be found at the Fair. The removal of much that is tedious and unnecessary from domestic work is indicated by the increased popularity of chromium-plated ware and of stainless steel and stainless silver articles, and by the space allotted in the Fair to the exhibition of devices for domestic mechanisation. The exhibition in larger quantities of open-air equipment of all kinds indicates that increasingly the leisure of the people is being used in healthy pursuits.

At Olympia, the exhibition is, as previously, divided into sections according to industries, and it is perhaps symbolic of the increasing recognition of the co-operation which must exist between science and industry, that the section devoted to the exhibition of the products of the Scientific and Optical

Instruments Group should occupy a prominent position near the main entrance to the Fair. The exhibits of the various firms in this section are placed so compactly together that a visual impression is conveyed of the co-operation and joint effort which is to be found among the members of the industry. The instruments shown are mostly optical in character, and one is reminded again of the large part played in scientific and industrial life by the products of the optical firms. Besides the normal instruments for laboratory equipment, special instruments are shown for use in aeronautics, astronomy and meteorology, together with those specially adapted to nautical and surveying requirements. One is impressed by the success which has been attained in so many of the instruments in combining the robustness required for industrial use with the necessary delicacy of movement.

Few things have been more striking of recent years than the development of long-distance telegraphy. It is but a short time ago that the first photographs were telegraphed from Australia to England, and quite recently a cinematograph film was exhibited in England showing events which had taken place but a few hours earlier in Australia. The exhibit of Cable and Wireless Ltd. is, on this account, of special interest. The modern system of long-distance telegraphy is admirably shown at its stand. The types of apparatus used for this work are presented in actual operation, and a study of the receiving and transmission units, magnifying relays, distortion removers and regenerators gives the visitor a clear idea of the inventive research which has enabled long-distance telegraphy to become part of his daily life. Realism is added to the demonstration by the fact that a written telegram, handed in at one end of the stand, is delivered as an automatically typed message at the other end after having passed through the complete system.

The chemical industry provides another example of the co-operation which may exist between firms in the same industry to their mutual benefit. Messrs. Hopkin and Williams and British Drug Houses Ltd. have combined their knowledge and experience to further the production of chemical reagents of an exceptionally high standard of purity, and these reagents are being exhibited by the firms. The very large field covered by the activities of Imperial Chemical Industries Ltd. is well illustrated by the fact that this firm has thought it worth while to devote a large portion of its space at the Fair, not to the display of its products, but to a presentation of its sales machinery. By means of interesting maps, the way in which chemical products enter into almost every phase of industry throughout Great Britain is clearly demonstrated. The same firm is making a special point of the hydrocyanic acid method of fumigation, especially for the cleansing of vermin-infested houses. Great success is claimed for this method of fumigation, and specimens of the fumigant and of its prospective victims are shown. The same fumigant has a variety of other and more pleasant uses, the removal of fruit-damaging insect pests from orange groves being specially emphasised as being of interest to overseas visitors.

Of the other industries represented at the Fair at Olympia, no section is more attractive, and certainly none more colourful, than that of the glass and pottery trades. A more perfect blending of utility and beauty can scarcely be imagined. It is perhaps fitting that the products of possibly the most ancient craft represented at the Fair should appear so near to perfection. The beauty of the exhibits is enhanced by the excellent lighting, and the stands furnish an example of the use of modern lighting effects to improve the display of goods. Quite near to the glass and pottery section, on the floor above, is a large area devoted to plastics, and it is not uninteresting to compare the products of this very modern industry with those of the very ancient one mentioned above. The increasing use which is being made of plastic materials is reflected in the very large increase of space occupied by the plastic group. In this industry the gap between laboratory experiment and workshop practice has been most effectively and rapidly bridged.

The fact that in London alone more than fifteen hundred firms are exhibiting almost every variety of manufactured articles makes it obviously impossible in a limited space adequately to describe such a Fair. In addition to these firms, one hundred and thirty-four inventors are displaying for the first time to the purchasing public the results of their ingenuity, which range from rubber contrivances for the prevention of housemaid's knee to a mechanical device for 'breaking-in' new pipes.

At the White City every phase of textile manufacture is represented; whilst the furniture section at the same place presents a wide field of interest to those concerned with the evolution and modern developments of furniture. The Fair remains open until March 1. The Engineering and Hardware Section opens in Birmingham on May 20.

University and Educational Intelligence

CAMBRIDGE.—At the Congregation of the Regent House a grace will be submitted appointing Prof. G. H. F. Nuttall, Magdalene College, emeritus professor of biology, Prof. E. D. Adrian, Trinity College, Prof. R. C. Punnett, Gonville and Caius College, Balfour professor of genetics and Mr. C. Forster-Cooper, Trinity Hall, University reader in vertebrate zoology, delegates from the University to the tercentenary of the National Museum of Natural History in Paris next June.

At Newnham College the Henry Sidgwick Memorial Lecture will be delivered on March 9 in the College Hall at 5 p.m. by Sir John Russell, director of the Rothamsted Experimental Station. The subject of the lecture is "The Impact of Science on the National Life".

THE thirteenth Unity History School will be held in Rome on April 15–22. The subject of the meeting will be "Science in the Modern World". On April 15, the inaugural lecture entitled "Science and Philosophy" will be delivered by Prof. F. Enriques, president of the School of the History of Science, University of Rome. Other lectures will be delivered by Mr. F. S. Marvin, director of the Unity History Schools, Prof. H. Dingle, Dr. W. A. Parr, Prof. E. Radl, Dr. C. H. Desch, Prof. C. Formichi, Dr. G. Sarton, and M. Lheritier. Several discussions have also been arranged. Further information can be obtained from Mrs. K. E. Innes, 29 High Oaks Road, Welwyn Garden City, Herts.

VOCATIONAL guidance service finds a valuable auxiliary in the *Journal of Careers* (monthly, 1*s*.). The December issue contains "The Prospect in

Surgery" by Sir Holburt Waring, a sequel to an article in the preceding month by Sir Humphry Rolleston on general medical practice and the main branches of specialisation. Sir Holburt gives expression to a view which, he says, will be considered in many quarters as revolutionary, namely, that the methods which are beginning to be practised in industry—selection on account of special aptitude, mentality and physical characteristics, might well be applied in surgery and also in the various branches of medicine. Considerable space is devoted to civil aviation : in addition to the first of a series of articles on the opportunities of new careers which the development of flying will offer, there is a summary of an address by Prof. Sutton Pippard to the Royal Aeronautical Society on the training of an aeronautical engineer. Veterinary surgery as a profession for women is discussed by Beatrice Lock, this being the second of a series of articles on "Women in the Professions". Another useful series deals with the prospect for public school and secondary schoolboys in the iron and steel industry, the article in the December issue being on technical and commercial posts. Lieut.-Col. Levey, managing director of the West African Information Bureau, writes on the prospects for British commerce in West Africa. The *Journal* has not failed to direct attention to the complaint, voiced in the presidential address to the Association of Special Libraries and Information Bureaux by Sir Richard Gregory, of the inadequacy of the arrangements made for the treatment of scientific news in daily and weekly newspapers. New fields of work should be opened up for science graduates with journalistic ability.

Science News a Century Ago

Telford and the Institution of Civil Engineers

At a special meeting of the council of the Institution of Civil Engineers held on February 23, 1835, the following extract from the will of Telford was read : "To the president for the time being of the Civil Engineer Institution in trust, the interest to be expended in annual premiums under the direction of the Council, 2,000£."

"All my scientific books, book cases, prints and such drawings, as my executors shall consider suitable, are to be delivered to the Civil Engineer Institution for its use and benefit, on condition, that all those articles, as well as the books, prints and drawings, shall, in case of the said Institution being discontinued, be delivered to the Royal Society, Edinburgh, for its use."

The council resolved that the premiums should be both of an honorary and pecuniary nature, and that the honorary premiums should consist of gold, silver and bronze medals, and that in the distribution of premiums no distinction should be made between natives and foreigners.

The Zoological Society

On February 24, 1835, Owen read a paper to the Zoological Society entitled "Description of a Microscopic *Entozoon* infesting the Muscles of the Human Body". He said that upwards of fifteen different kinds of internal parasites were already known to infest the human body, but none had been found of so minute a size, or existing in such astonishing numbers, as the species he described. The muscles of bodies dissected at St. Bartholomew's Hospital had been more than once noticed by Mr. Wormald, the demonstrator of anatomy, to be beset with minute white specks ; and this appearance having again been remarked in the body of an Italian, aged forty-five years, by Mr. Paget, a student at the hospital, who suspected it to be produced by minute Entozoa, the suspicion was found to be correct, and Owen had been furnished with portions of the muscles for examination. An account of his observations was published in the *Philosophical Magazine* of June 1835.

University of London

The annual general meeting of the proprietors of the University of London was held on February 25, 1835. The report expressed satisfaction at the prospects of the institution, and stated that the number of students in the Faculty of the Arts and Law during the year had increased from 122 to 137, the number of students in Medicine from 347 to 371. The number of pupils in the junior school had increased from 284 to 303. The total receipts for 1833 had been £9,890 3*s*. 0*d*. and for 1834 £9,971 16*s*. 8*d*.

The Natural History of Wasps

A paper on the natural history of wasps was read on February 27, 1835, by the Rev. E. T. Bigge, of Merton College, to the Ashmolean Society of Oxford. The object of the paper, said the author, was to correct the mistakes into which several writers had fallen, and to state the results of his own observation on two species, *Vespa vulgaris* and *Vespa Britannica*. The former, he said, was common in all parts of the kingdom ; the latter, though occasionally met with in the southern counties of England, was abundant in the northern districts, and in Scotland, as well as in the northern parts of Europe. Having directed attention to the points of difference in the two species, the author went on to state some interesting facts relating to both species. Societies of wasps, as of bees, consist of three different classes of inhabitants, males, females and neuters. The neuters, or imperfectly developed females, are the common wasps which infest our houses and gardens, and form the majority of the colony. The author had never seen a nest of either species in which he had not observed, after 9 o'clock, in the summer months, a sentinel watching the entrance to the nest. A ground nest has two apertures, one for entry and one for exit. It is curious that if one stops up a wasps' nest, the returning wasps will not sting the aggressor, while those which escape from the inside will attack him instantly.

Weather in the United States

In the *Mechanics' Magazine* of February 28, 1835, it was stated that : "The winter in America has been one of almost unprecedented severity. In January the thermometer sunk at New York to 5° below zero—at Baltimore to 10°—at Washington to 16°—at Albany to 32°—at Montreal to 35° and at New Lebanon in Columbia county to below 40°, the mercury in the bulb being 'congealed and for some time immovable'. The harbours of Portland, Newburyport, Boston, New Bedford, New Haven, Philadelphia and Baltimore have all been frozen over ; some of them hard enough to bear carriages."

Societies and Academies

LONDON

Royal Society, February 14. G. BARRY, J. W. COOK, G. A. D. HASLEWOOD, C. L. HEWETT, I. HIEGER and E. L. KENNAWAY: The production of cancer by pure hydrocarbons (3). Tests for cancer-producing activity on the skin of mice have been carried out with a number of pure compounds of known molecular structure, most of which have been polycyclic aromatic hydrocarbons. In all, some 140 different compounds have now been tested. Of these, 69 are related to 1 : 2-benzanthracene and 25 of them have given positive results. 1 : 2-benzanthracene itself has very little carcinogenic activity, but such activity is shown by derivatives in which substituents (saturated alkyl groups or additional rings) are attached to positions 5 or 6, or both. The most active so far encountered is methylcholanthrene, a hydrocarbon which was obtained by simple chemical means from the deoxycholic acid of bile. In this way a direct relationship has been established between the carcinogenic compounds and some normal constituents of the body. Of 71 compounds not related to 1 : 2-benzanthracene, 65 have given completely negative results. Of the 6 compounds which gave positive results, only 3 : 4-benzphenanthrene ahd considerable activity. The remaining 5 compounds gave only 10 tumours (2 epitheliomas and 8 papillomas) in 360 mice. By way of contrast the 25 carcinogenic compounds *related* to 1 : 2-benzanthracene gave 437 tumours (335 epitheliomas and 102 papillomas) in 1,220 mice. C. H. WADDINGTON, J. NEEDHAM, W. W. NOWINSKI and R. LEMBERG: Studies on the nature of the amphibian organisation centre. (1) Chemical properties of the evocator. An evocator, that is, a substance capable of causing the ectoderm of the amphibian gastrula (*Triton* spp., axolotl) to differentiate into neural tissue, has been obtained in ether extracts of whole newt bodies and of mammalian liver. The active substance is present in the unsaponifiable fraction, and in the part of that fraction precipitable with digitonin. It comes out with the cholesterol if the unsaponifiable fraction is allowed to crystallise from alcohol in the cold, and is probably of a sterol-like nature. An active ether-soluble substance, which is also precipitable with digitonin, has been isolated from crude preparations of glycogen. The whole of the evocating activity of glycogen may be due to the admixture of this substance. C. H. WADDINGTON and D. M. NEEDHAM: Studies on the nature of the amphibian organisation centre. (2) Induction by synthetic sterol-like substances. Certain synthetic hydrocarbons have been implanted into young amphibian gastrulæ. Inductions of neural tissue have been performed by 1 : 9-dimethylphenanthrene, 9 : 10-dihydroxy-9 : 10-di-*n*-butyl-9 : 10-dihydro-1 : 2 : 5 : 6-dibenzanthracene, and 1 : 2 : 5 : 6-dibenzanthracene. The first two of these are œstrogenic and the third carcinogenic. There is therefore probably a group of evocating substances which overlaps with the group of œstrogenic and carcinogenic substances. This provides the first satisfactory evidence that more than one substance is capable of evocating, and suggests that the naturally occurring evocator is a sterol-like substance.

EDINBURGH

Royal Society, February 4. W. L. BRAGG: The new crystallography (Bruce-Preller Lecture). The mapping of atomic arrangement by X-ray analysis, first applied only to crystalline solids but more recently extended to glasses, liquids and gases, has now been pursued for more than twenty years. A review of the influence which this new knowledge has had in many branches of science is impressive. Some idea of this influence can be gained by taking examples in inorganic chemistry, organic chemistry, mineralogy, metallurgy and biochemistry. Though such isolated examples are only random soundings over a wide area, they serve to give an impression of the precision, simplicity and novelty of outlook which a knowledge of the actual atomic arrangement introduces. They also indicate the fascinating lines of research which are opening out ahead.

PARIS

Academy of Sciences, January 7 (*C.R.*, 200, 101–176). EMILE BOREL: An elementary demonstration of formulæ on the distribution of prime numbers. V. ROMANOVSKY: A formula of A. R. Crathorne relating to moments. ALEXANDRE WEINSTEIN: The stability of plates with fixed edges. PIERRE MASSÉ: A partial differential equation of the theory of intumescence. GÉRARD PETIAU: The wave equation in a relative movement. NICOLAS KRYLOFF and NICOLAS BOGOLIUBOFF: Study of the case of resonance in problems of non-linear mechanics. LÉON CAPDECOMME: The use of a buffer accumulator for stabilising the current supply of an incandescent filament. The accumulator is placed in parallel with the filament on the main circuit: its automatic regulation is shown to be at least as good as any other automatic regulators in use and has the advantage of simplicity. NÉDA MARINESCO: An ultra-micrometer with stabilised valve. CONSTANTIN SALCEANU and DUMITRU GHEORGHIU: The magnetic susceptibility of organic liquids. Applications to the law of additivity. Using an improved method of measuring, giving an accuracy of the order of 1 per cent, the authors cannot confirm divergencies found by other workers from the additivity law. MARIO REGGIANI: The influence of electrolytes on the formation and stability of the metallic colloids obtained by ultra-sonic waves. In the preparation of colloidal mercury by means of ultra-sonic waves, the velocity of formation, the stability and diameter of the particles are all susceptible to a very slight chemical modification of the dispersing phase. The effect of traces of albuminoids (less than 0·1 per cent) is very marked in this respect. JEAN COURNOT and GEORGES MEKER: The cementation of copper by aluminium. ANDRÉ GIRARD and GEORGES CHAUDRON: The constitution of rust. Experiments on the cause of production of the magnetic oxide of iron by metallic iron in the presence of rust. HENRI GUÉRIN: The reduction of the arsenates of the alkaline earths by carbon. Barium arsenate. A detailed study of the products given by a mixture of barium arsenate and carbon heated in a vacuum at temperatures between 500° C. and 1,200° C. PIERRE DUBOIS and EDOUARD RENCKER: The dilatometric study of the dehydration and thermal decomposition of some manganese compounds. ANDRÉ MORETTE: The reduction of the vanadium oxides by carbon monoxide and by carbon. XAVIER THIESSE: The preparation and properties of sodium ferrate (hypoferrite). A solution of ferrous sulphate dropped into a boiling concentrated caustic soda solution gives a green solution of hypoferrite containing up to 20 gm. of $Fe(OH)_2$ per litre. The solid salt is precipitated on

cooling. The alkaline solution does not appear to be oxidised by air. JEAN AMIEL: The preparation and properties of some cupritetrachlorides and cupritetrabromides. JOSEPH BIECHLER: Researches on the dicyanimides. Sodium amide and cyanogen bromide react, under conditions specified, giving a good yield of sodium dicyanimide. MARCEL MATHIEU: The structure of the dinitrocelluloses. Results of an X-ray study. MARCEL ROUBAULT: The origin of the crystalline schists of Kabylie de Collo (Department of Constantine, Algeria). MLLE. J. ROESS: Study of the elasticity of rocks by the method of restitution. The application of photography to the falling ball method of measuring elasticity. BORIS CHOUBERT: The ancient strata of Gabon. FRANCE EHRMANN and JACQUES FLANDRIN: Concerning the large Lepidocyclines of the Eocene of Beni-Afeur (south of Taher, Departement of Constantine). PAUL FALLOT and GONZAGUE DUBAR: The presence of Lias containing Rhynchonellina in the Spanish Rif. ALBERT F. DE LAPPARENT: The nummulitic transgression in the Provence Alps. DANIEL SCHNEEGANS: The discovery of strata with *Cardita Beaumonti* at Gabon (French Equatorial Africa). JACQUES DE LAPPARENT: The structure of the mountains and the tectonic position of the bauxites on the slopes of Parnassus (Greece). ADOLPHE LEPAPE: The origin of the helium of natural gases. The relation between the richness in helium and of lithium in certain saline hydro-mineral springs. EM. DE MARTONNE and MME. FAYOL: A formula for the aridity index. JOSEPH BLAYAC and MLLE. MARIE CHAUBET: Palæontological discovery in the Llandeilo sub-stage of the Ordovician of the Montagne-Noire. PIERRE DOPTER and MLLE. THÉRÈSE FRÉMONT: The absorption of nitric nitrogen and of ammoniacal nitrogen by the higher plants. MLADEN PAIC and MARCEL PHILIPPE: A pigment elaborated by the diphtheria bacillus. Some pigment is absorbed from the culture broth by collodion, but the toxicity of the culture is not reduced. ALEXANDRE BESREDKA and LUDWIG GROSS: The importance of the point of inoculation in the evolution of the Ehrlich sarcoma.

LENINGRAD

Academy of Sciences (*C.R.*, 4, No. 3). A. SVETLOV and V. STROGANOV: Solution of a magnetic problem in two dimensions. A. ARSENJEVA: Photo-electric transmission in crystals of silver chloride. G. KRUTKOV: Linear problems of the theory of Brownian movement (3). A. LEVASHOV: A contribution to the theory of gravitation. V. FESENKOV and E. PIASKOVSKAJA: Brightness of the day-time sky and the scattering of light in the atmosphere. A. BALANDIN, J. EIDUS and N. ZALOGIN: Formation of butadeine and acetylene from ethylene by the high-frequency discharge. V. SADIKOV and V. MENSHIKOVA: Action of the animal proteolytic enzymes on the vegetable proteins. The proteins in seeds are not affected by pepsin and pancreatin. G. LEVITSKY: New fixing solutions revealing the morphology of chromosomes. E. HASRATIAN: Physiology of irradiation and concentration of processes in the cortex of the cerebral hemispheres. I. VASILJEV: Vernalisation of winter varieties and frost resistance. The process of vernalisation lowers the frost resistance of winter varieties. V. KARASIK and M. LICHATCHOV: Relation between the chemical nature and the biological activity of the dihydroxide of methylphenarsazine and of its derivatives. G. FLEROV: Some geographical and historical variations in the Eurasian Ungulates. J. SCHAXEL: Determination of the regeneration of extremities in axolotl (1). O. ZVIAGINZEV: A new mineral containing metals of the platinum group. B. LICHAREV: The problem of the age of the Safet-Daron chalk in Darvas.

(*C.R.*, 4, No. 4). I. VINOGRADOV: Some theorems of the analytical theory of numbers. N. KOSHLJAKOV: A general summation formula and its applications. L. KELDYSH: Measurable functions. B. A. ALEXANDROV: Quantum conditions and the Schrödinger equation. I. KURCHATOV: Artificial radioactivity and Landé's scheme. N. ZELINSKIJ, B. MICHAILOV and G. ARBUZOV: Thermal dissociation of the carbohydrates of the cyclohexane series. J. RYSS and R. URICKAJA: Dissociation of magnesium chromate. V. SADIKOV, V. ROZANOVA and G. NOVOSELOVA: Autoclave splitting of blood albumin by means of a 2 per cent potassium carbonate solution. G. LEVITSKIJ: Fixation changes of the chromosome body. S. KRAJEVOY: Trisomics and heterochromosomes in *Scorzonera nervosa*, Trevir. N. SHAPIRO and R. SEREBROVSKAJA: Relative mutability of the *X*- and the second chromosomes of *Drosophila melanogaster*. The mutation frequencies of the *X*- and the second chromosomes are proportional to the lengths of the genetically active parts of these chromosomes. R. BERG: Relative mutation frequencies on *Drosophila* chromosomes. O. TCHERNOVA: A new, widely distributed genus of may-flies from the northern regions of the U.S.S.R. J. SCHAXEL: Determination of regeneration in the extremities of axolotl (2). Transplantation of regeneration stages.

VIENNA

Academy of Sciences, December 6. HERBERT HABERLANDT and KARL PRZIBRAM: A labile coloration of fluorite. A number of specimens of greenish or bluish fluorite develop, either in the natural state or after irradiation with radium, a violet colour when exposed to ultra-violet light at the temperature of liquid air. This coloration, which soon fades when the mineral resumes the ordinary temperature, is probably related to the excitation of Lenard's short-lived centres. RICHARD GROSSMANN: Measurement of strong polonium preparations by ionisation in pure nitrogen. By ionisation of nitrogen of such high purity that the negative carriers are free electrons, the activity of polonium preparations showing ionisation currents up to 42,000 electrostatic units may be measured. KARL STRUBECKER: Lie's representations of the line elements of the plane on points of space. ARTHUR WAGNER: Critical remarks on the daily course of cosmic ultra-radiation from records taken on the Hafelekar (2,300 m.). Observations made from September 1931 until December 1933 are analysed and discussed, various sources of error being indicated. RUDOLF WAGNER: Methodical specification of pentameric pre-floration.

December 13. ELISABETH MATZNER: Atomic disintegration by neutrons. The elements carbon, aluminium, sulphur, iron, cobalt, nickel, copper, zinc, gallium, molybdenum, silver, cadmium, tin, platinum and lead have been investigated, as regards atom disintegration by beryllium neutrons excited by polonium, by two different methods, which give

concordant results. The greatest effects were found with carbon and nickel, and the smallest with lead and tin. HERBERT HABERLANDT: Investigations on the luminescence of fluorites and other minerals. Various new fluorites showing a natural red radio-photofluorescence are recorded, two of them showing the presence of radioactive inclusions. In certain fluorites with a yellowish-white photofluorescence, the active impurities are bituminous in character. JOSEF SCHINTLMEISTER and GEORG STETTER: Investigation of the disintegration of the light elements with the double-tube electrometer. All the light elements as far as chlorine have been examined. The fall in the disintegration is approximately exponential from the maximum for nitrogen, with a periodic function superimposed, the values for the odd elements being always greater than those for the even ones. A. SKRABAL: Reaction cycles. Reaction cycles are based on a reaction scheme which may be decomposed into two or more separate schemes with the same total reaction. These reactions occur far more frequently in chemical kinetics than is generally supposed, and include all reactions which proceed along two or more paths. OTTO AMPFERER: Tectonic studies in the Rhine valley.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, February 24

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—M. A. Phillips: "Fossil Mammals".*

Monday, February 25

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—G. Seccombe Hett: "Bats".*

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Sir Norman Watson: "In the Coast Range of British Columbia". (Film.)

ROYAL SOCIETY OF ARTS, at 8.—D. R. Wilson: "Factory Accidents". (Shaw Lecture. Succeeding lectures on March 4 and 11.)

Tuesday, February 26

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. J. R. Mathews: "The Northern Element in the British Flora" (succeeding lectures on February 27 and 28).*

ROYAL SOCIETY OF ARTS, at 4.30.—L. A. Jordan: "Empire Production of Tung Oil".

Wednesday, February 27

UNIVERSITY COLLEGE, LONDON, at 5.30.—I. C. Gröndahl: "Norwegian Students' Life in the Nineteenth Century" (succeeding lecture on March 6).*

Thursday, February 28

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. R. A. Sampson: "Astronomical Time".*

THE CHEMICAL SOCIETY, at 8—(at the Royal Institution, Albemarle Street, W.1).—Dr. A. S. Russell: The Madame Curie Memorial Lecture.*

Friday, March 1

GEOLOGISTS' ASSOCIATION, at 7.30.—(at University College, Gower Street, W.C.1).—Annual General Meeting.

Sir Albert E. Kitson: "Outlines of the Geology of the Gold Coast, British West Africa".

ROYAL INSTITUTION, at 9.—A. Bryant: "Samuel Pepys: known and unknown".

Official Publications Received

GREAT BRITAIN AND IRELAND

The Institute of British Geographers. Publications Nos. 1 and 2: Transactions; and The Pastoral Industries of New Zealand, by R. Ogilvie Buchanan. Pp. xv+99. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd.) 7*s.* 6*d.*

The Registrar-General's Statistical Review of England and Wales for the Year 1933. (New Annual Series, No. 13.) Tables, Part 2: Civil. Pp. iv+130. (London: H.M. Stationery Office.) 2*s.* net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1608 (A. 160): Abstract—Constitution of Magnesium-Rich Alloys of Magnesium and Nickel. By J. L. Haughton and R. J. M. Payne. Pp. 2. (London: H.M. Stationery Office.) 2*d.* net.

The University of London Animal Welfare Society. Eighth Annual Report, 1st July 1933 to 30th September 1934. Pp. 16. (London.)

Scientific Horticulture (formerly the H.E.A. Year Book). Vol. 3, 1935. Pp. 228+xliv. (Wye: Horticultural Education Association.) 3*s.* 6*d.* net.

The Carnegie Trust for the Universities of Scotland. Thirty-third Annual Report (for the Year 1933–34) submitted by the Executive Committee to the Trustees on 6th February 1935. Pp. iv+82. (Edinburgh.)

Congrès International des Sciences anthropologiques et ethnologiques. Compte-rendu de la première Session, Londres 1934. Pp. xxxii+340. (London: Royal Anthropological Institute.) 25*s.*

British Chemicals and their Manufacturers: the Official Directory of the Association of British Chemical Manufacturers (Incorporated). Pp. 459. (London: Association of British Chemical Manufacturers.) Gratis.

London School of Hygiene and Tropical Medicine. Classified Catalogue of Books in the Library, including Departmental Libraries. Part 2: Classes C and D: Theory and Practice of Medicine and History of Medicine. Pp. ii+31–51. (London.) Gratis.

OTHER COUNTRIES

Cornell University: Agricultural Experiment Station. Bulletin 610: A Study of Practices in Feeding Infants; Results of a Survey of 657 Babies in Villages of New York State, 1930. By Rachael Sanders Bizal. Pp. 34. Bulletin 613: An Economic Study of Land Utilization in Montgomery County, 1932. By F. F. Hill and George T. Blanch. Pp. 50. Bulletin 614: Rural Social and Economic Areas in Central New York. Pp. 100. Bulletin 615: Clothing Purchased by Farm Families in Tompkins County, New York, 1927–28. By Beulah Blackmore. Pp. 44. Bulletin 616: Study of Artificial Incubation of Game Birds, 1: Temperature Requirements for Pheasant and Quail Eggs; 2: Humidity Requirements for Pheasant and Quail Eggs. By Alexis L. Romanoff. Pp. 39. Memoir 169: A Physiological Study of Dormancy in Tilia Seed. By J. Nelson Spaeth. Pp. 78+4 plates. (Ithaca, N.Y.)

Smithsonian Miscellaneous Collections. Vol. 91, No. 17: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—New Sponges from the Puerto Rican Deep. By M. W. de Laubenfels. (Publication 3283.) Pp. 28. Vol. 93, No. 1: The Effect of Ultraviolet Radiation on the Ova of the Ascarid Roundworms *Toxocara canis* and *Toxascaris leonina*. By W. H. Wright and E. D. McAlister. (Publication 3291.) Pp. 13. (Washington, D.C.: Smithsonian Institution.)

Colony and Protectorate of Nigeria. Annual Report on the Geological Survey Department for the Year 1933. Pp. ii+52+8 plates. (Lagos: C.M.S. Bookshop; London: Crown Agents for the Colonies.) 4*s.* net.

University of Michigan: School of Forestry and Conservation. Bulletin No. 5: The Hungarian Partridge in the Great Lakes Region. By Ralph E. Yeatter. Pp. 92. (Ann Arbor: University of Michigan Press.) 35 cents.

Palæontologia Sinica. Series C, Vol. 8, Fascicle 1: On the Carnivora from Locality 1 of Choukoutien. By Pei Wen-Chung. Pp. 222+24 plates. Series C, Vol. 8, Fascicle 3: On the Insectivora, Chiroptera, Rodentia and Primates other than Sinanthropus from Locality 1 at Choukoutien. By Chung-Chien Young. Pp. 166+10 plates. Series C, Vol. 10, Fascicle 1: On the Fossil Pisces, Amphibia and Reptilia from Choukoutien, Localities 1 and 3. By M. N. Bien. Pp. 36+3 plates. (Peiping: Geological Survey of China; The French Bookstore; London: Edward Goldston, Ltd.)

Trinidad and Tobago. Report on an Investigation into the Uses and Marketing of Forest Products in Trinidad and Tobago. (Council Paper No. 100 of 1934.) Pp. 85. 2*s.* 6*d.* Forestry Pamphlet No. 1: What Forestry in Trinidad Means. Pp. 12+2 plates. 6*d.* Forestry Pamphlet No. 2: The Forest Types of Trinidad and their Principal Species. Pp. 16+2 plates. 6*d.* (Trinidad: Government Printing Office.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 137 (Division of Chemistry, Series No. 134): Influence of Fertilizers on the Nitrogen and Carbon Cycles in Soils; Experiments carried out on the Red Loam of the Zebediela Area, Northern Transvaal. By Dr. P. Kamerman and H. Klintworth. Pp. 26. (Pretoria: Government Printer.) 3*d.*

Biological Movie Booklets. Vol. 1: Normal Cell Division. By Clyde E. Keeler. Pp. 46. Vol. 2: Maturation of Sperm. By Clyde E. Keeler. Pp. 94. Vol. 6: Fertilization. By Clyde E. Keeler. Pp. 65. (Washington, D.C.: American Genetic Association.) 3 vols., 1.50 dollars.

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