NATURE

SATURDAY, JUNE 30, 1923.

CONTENTS.

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

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

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

Position and Needs of the Science Museum Collections.

IN an article in another part of this issue an outline is given of the present state of advancement of the Museum building scheme at South Kensington, which was approved in 1912 and started in 1913. The scheme was that which the Departmental Committee on the Science Museum and the Geological Museum proposed in its Report of 1911 and 1912 as to (1) the purposes these museums should serve in the national interests; (2) the nature, arrangement, and development of the collections required for these purposes; and (3) the buildings required on the South Kensington site to house these collections. This was a logical reference, and the report dealt with it faithfully and effectively.

The discussion of the reference inevitably brought the reporting committee face to face with the problem of co-ordinating these two museums with one another and with the Natural History Museum. The committee found that there was in practice little or no overlapping of the fields of the three museums, and in the end it was able to formulate proposals by which the buildings of the three museums would be brought into direct communication. Thus the related parts of the great national collections in the sections of science concerned would be brought into a continuous series.

Under the scheme thus initiated, the individuality of the several museums and their administration under their existing responsible authorities would not be affected in any way; at the same time the group of museums would afford at a single centre, and in intercommunicating buildings, a real national museum representative of science. This feature of the recommendations of the committee was made possible by an arrangement with the Trustees of the British Museum, who were willing that the new Geological Museum building should be placed on a part of the ground allotted to the Natural History Museum, and should be a part, structurally, of the eastern extension of the Natural History Museum building.

The scheme is an admirable one. It provides for the mineral products of the earth complete museum representation as to natural history, geological structure, economic conditions, mining, metallurgy, and all physical and engineering investigations and appliances bearing on these. Further, it suggests lines for obtaining similar advantages in relation to other branches of science as the scheme comes to be applied in later stages.

The first item of the scheme was the erection of the Eastern Block of the new Science Museum, and this has shown so little progress since the War that the councils of a number of leading scientific and technical societies have found it necessary to direct attention to the matter and to ask that the building be expedited. In these times of financial straits it has been a national necessity to go slowly in the matter of new public buildings, and precedence in such work must be most carefully considered. In recent years few things have been so generally and so fully recognised as the magnitude of the contributions which physical and mechanical science have made to the progress of the country in knowledge, in industries, in trade, and in war, and accordingly it might have been assumed that the work on the Science Museum building, interrupted by the War, would have had a place in the first rank of the priority list. Yet here is the Science Museum, which is charged with the duty of affording public illustration and visual exposition of the great current advances in the physical sciences and in the applications of science to industry, practically obstructed in all new work by lack of space. The functions of the museum are so closely related to important national interests that its equipment has become a matter of urgency, and the facts summarised in our article on the subject suffice to show the need for an emphatic appeal that the continuance of the work on its building should have an assured place in the programme of new national buildings.

The building now in progress is the outcome of action taken in pursuance of representations made to the Board of Education in 1909 by a deputation and a memorial from those prominently interested in the advancement of pure and applied science. In presenting the memorial, Sir Henry Roscoe quoted from the 1874 report of the Duke of Devonshire's Commission on Science, strongly recommending the establishment of a museum representative of all branches of physical science, both pure and applied. He and those with him in the deputation then emphasised the necessity for proper housing for such a museum, and the advantages of properly housed collections. They pointed out, too, that without adequate accommodation the Museum could not benefit as it otherwise would by gifts of many objects of interest which have high value for museum collections.

The fact is that, in the matter of buildings, this museum has lagged far behind the museums that represent other branches of knowledge and of culture. One may well ask how this has come about. The answer is largely one of history. The Science Museum is the youngest of our national museums: for although science collections were first prepared for museum exhibition in 1857, it was not until twenty years later that the real possibilities of such collections began to be widely recognised. The earlier collections were formed with the view of following up in particular directions the impulse which the Exhibition of 1851 had given to public interest in science and industry. At that time the larger groups of objects came under the following headings: Foods, animal products of industrial value, building structure and materials, models of machinery and educational apparatus. It was the Fourth Report (1874) of the Royal Commission on Scientific Instruction and the Advancement of Science that directed attention to the wide field of usefulness that was open to well-devised science collections; and it was the demonstration afforded by the great loan collection of scientific apparatus, formed at South Kensington in 1876, that proved the turning-point in the aims of the museum collections. Many of the objects lent for that temporary collection became the property of the nation and formed the nucleus of the collections of to-day. It is right to note here that the advance then made in the museum ideal owed much indeed to the initiative and to the indefatigable labours of the late Sir Norman Lockyer, who was secretary to the Commission.

Almost concurrent with the wider conception of the relation of the Museum to pure science came the recognition of the importance of preserving and exhibiting actual examples of great inventions. The many-sided appeals of such objects had led Mr. Bennet Woodcroft to form a collection that was, and must always be, unique, and the transference of his collection to the Department of Science and Art in 1883 laid the foundation of the fine collection which now illustrates machinery and the history of invention.

Successive committees have reported on various aspects of the uses and needs of the Science Museum. Their reports in 1886, 1889, 1897, 1898, and 1900 form a long chain of scientific and technical opinion. These, however, failed to secure the full measure of official backing and of national support which they well merited. Yet in their estimates of needs they were most modest—perhaps *too* modest. Men of science accustomed to work in laboratories providing only the bare necessaries for their investigations, failed to realise that the great museum-visiting public needs space in which to move about freely, and requires the exhibition of objects rather than a mere opportunity of examining them under difficulties. Be that as it may, in accordance with scientific habit they limited their recommendations, in matter and in measure, to needs which could be proved up to the hilt; but people accustomed to the evaluation of reports in other interests—reports made, it may be, with greater imagination and longer views—had acquired a habit of making a large discount from the claims made in commission reports generally.

Since the new departure in the early 'eighties the Science Collections, alike in pure and in applied science, have had many acquisitions of great and abiding interest, and the methods of displaying these have developed steadily. The aim of the Museum has been to do all that considered preparation of objects and appropriate methods of exhibition can do to enable scientific instruments, machinery, models, etc., to speak for themselves. By exhibited objects, it affords telling illustration and exposition pertaining to the various branches of science within its field and of their applications in the arts and industries. It also preserves appliances which hold honoured places in the progress of science or in the history of invention, and with such exhibits it associates the names of the great men to whom the world owes these successive advances. This human element in the interests which the Science Collections present accounts for no small part of the crowds who visit the galleries at times when any large section of the public is free from work. The exhibited machines, or other inventions which have created or revolutionised industries and have altered conditions of life, arouse in even the most casual of visitors something more than admiration for the genius and skill of the inventor. Such objects as those illustrating early steam-engines, telegraphs and telephones, or the successive stages of the development of ships, never fail to appeal to popular intelligence and imagination. Indeed, many of the treasures of the Science Museum are irreplaceable in respect of value for the intellectual inspiration of the people.

For the use of the Museum by the general public, larger space for exhibition and more ample gangways for the circulation of visitors are the most pressing needs; but a suitable setting for the collections, and a worthy front and entrance to the building, are essential to the recognition of the real value of the Museum as a factor in the intellectual machinery of the nation. Students and investigators who use the Museum need all these; but they need more. The report of Sir Hugh Bell's committee sets out the directions in which material facilities are required for the critical examination of instruments, or for public or private exposition of objects, but until an adequate building is provided for the Museum collections these uses are seriously limited; thus individuals and institutions interested in physical and applied science must wait for some years yet before they can enjoy the wider uses pointed out in the committee's report.

The deputation to the president of the Board of Education in 1909 pointed out that by far the largest part of the Science Collections come as gifts or loans, so that if an adequate and worthy building were provided, it need not be anticipated that the annual subsidy for purchases would be on the high scale required for the other great national museums and galleries. The maintenance vote is also relatively small, and the capital expenditure required for the building is not even now deterrent. It is not too much to expect that in these circumstances the work on the buildings will be pushed forward vigorously and without break.

Meteorological Physics.

The Air and its Ways: the Rede Lecture (1921) in the University of Cambridge, with other Contributions to Meteorology for Schools and Colleges. By Sir Napier Shaw. Pp. xx+237+28 plates. (Cambridge: at the University Press, 1923.) 30*s.* net.

IN this volume Sir Napier Shaw has collected fifteen different lectures and papers upon a variety of different subjects, to a few only of which we can here refer. Throughout the whole book is a number of leading ideas, for which the author has been an indefatigable and mostly also a successful advocate, to the benefit of meteorological science.

The first point which strikes the reader when he opens the book is twenty-four plates representing the normal distribution of the meteorological elements over the globe. Several of these charts are new from the author's hand. By placing these charts at the beginning of the book, and by returning to them incessantly in discussing the special questions in the subsequent papers, the author has succeeded in emphasising strongly his view of "the weather of any locality as part of the weather of the world." Statistics can be made for a single locality. Atmospheric events, on the contrary, can never be understood from local, but only from universal points of view.

To understand the phenomena of the weather means, according to Sir Napier Shaw, "to bring our knowledge of the air into relation with the laws of physics, as established in the laboratory, and therefore particularly with the law of energy." We meet with this view already in the charmingly written first lecture, "Meteorology for Schools and Colleges," and it follows us all through the book to the last lecture on "The Artificial Control of the Weather." An important consequence of this view of meteorology as applied physics forms the subject of the second lecture on "Pressure in Absolute Units."

Among the leading ideas of a more special meteorological nature the author emphasises in the preface three as especially important—those of "balanced forces," of "eviction," and of "resilience." In his discussions of meteorological phenomena these principles recur repeatedly. We meet with an example of the application of the principle of resilience on the first page of the first lecture, when we read this characteristic remark concerning the conditions for the formation of orographic rainfall: "But when you come to think of it, the explanation requires that the air on the windward side has to be made to flow up-hill, and no fluid which technically must be called heavy, as it is affected by gravity, even if it is as light as air, flows up-hill without protest. It prefers to go round, and will exhaust all the possibilities of doing so before submitting to be driven over." This principle of resilience should be remembered not least by mathematicians who will work out the theory of atmospheric movements. In theoretical hydrodynamics we generally assume the equation $\varsigma=f(p)$, density as a function of the pressure. This equation leads to that state of "unlimited miscibility" which excludes resilience and would make it possible for the air to flow up-hill without protest. But the true equation $\varsigma=f(p, \theta)$ permits the air to take a stable stratification, a permission of which it makes a most extensive use; with the consequence that we have laws of motion very different from those of the idealised fluid, in which $\varsigma=f(p)$. I can scarcely be wrong when I say that this equation has for more than a century acted as a barrier which has prevented the representatives of theoretical hydrodynamics from taking up meteorological problems with success.

The principle of "balanced forces" merits great attention, not only in qualitative discussions but also perhaps still more by the attempts to work out mathematical theories of atmospheric motions. The author gives no mathematical formulation of the principle. But if I have understood him rightly, I should call it rather very good advice than a principle. The most obvious way of developing atmospheric movements might seem to be this: first to consider the state of equilibrium, and then to examine the consequences of a disturbance of it, in the case before us of a disturbance of thermal origin. But on account of the rotation of the earth there is a very long and difficult way from the state of equilibrium relative to the earth to the ultimately resulting motion. The primary tendency is the production of a direct flow from the cold to the warm areas. But this tendency is almost completely checked by the effect of the earth's rotation. Instead of the direct flow from cold to warm areas, we get a circulation cyclonic round the warm and anticyclonic round the cold areas. Only a small residual leakage is left, conveying very gradually air from the cold to the warm areas. For this leakage the process of "eviction" plays an important part.

Now Sir Napier Shaw's advice is to shorten this long development, which it is very difficult to give in a satisfactory form, and to start with that state of steady motion relative to the earth which is characterised by the "gradient wind." This gradient wind, by which pressure gradient and deflecting force balance each other, gives immediately the cyclonic circulation round the warm areas and the anticyclonic circulation round the cold. Then, in the second approximation, we have to add to this pure circulation the further disturbances, as those connected with convection and that particular form of convection for which Sir Napier Shaw has introduced the word eviction. No doubt his advice will be followed more and more, both in elementary treatises and especially in mathematical theories, for which this may prove to be the only practicable way.

I cannot finish this notice without mentioning Sir Napier Shaw's brilliant style of writing, the many adequate expressions and striking comparisons by which he succeeds in making the subject clear and ensures that the reader does not forget the main points. He is a master of finding the right words, and is not less a master of illustrating the text by characteristic diagrams. I only regret that he has not found place in the book for that really historical diagram by which he formulated his protest against the old cyclone theory and gave the main structure of the new one, replacing the fine logarithmic spirals running asymptotically to a centre in the old model simply by three sets of straight lines, of which two sets meet each other at right angles. V. BJERKNES.

Philosophy for Men of Science.

Scientific Thought. By Prof. C. D. Broad. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. 555. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1923.) 16*s*. net.

AS men of science are usually impatient, if not contemptuous, of philosophical discussion, Prof. Broad may be thought rash to address a philosophical work specifically to them, particularly as he is occupied in discussing the notions of space, time, matter, and motion, about which the man in the laboratory considers himself better qualified to speak than the philosopher. The author, however, brings to his task both a knowledge of mathematics and physics and an appreciation of the efforts of philosophers in the "peculiarly obstinate attempt to think clearly," which constitutes their chief task. Moreover, unlike many philosophers and men of science, he expresses himself clearly, so that any one who reads his book will discover at least one philosopher who does not "tell us what every one knows in language that no one can understand."

Part 1 consists of an analysis of the conceptions of space and time in modern physics and leads up to an account of the special and general theories of relativity. This has all been done before, but not quite in the same way. The author starts at the beginning, or what ought to be the beginning of any such discussion, by giving a simple account of Prof. A. N. Whitehead's "Principle of Extensive Abstraction." This principle provides a rational method of passing from the actual facts of sense-experience to the highly sophisticated conceptions, such as points and lines, that are necessary for geometry and mathematical physics, and is indispensable for any proper theory of space and time. Prof. Broad's exposition provides a good introduction to Prof. Whitehead's own decidedly difficult works. In the second chapter on time and change, with Prof. Whitehead's treatment of time as a basis, some valuable and original ideas are developed. This chapter is perhaps the most important in the whole book. The rest of Part 1 follows well-established lines and does not call for special comment, except in so far as it gives a clear account of a difficult subject.

In Part 2 the author takes up his problem from a different point of view, that of the relation of the physical theory of material bodies to the facts of sense-experience. Here Prof. Broad is for the most part breaking new ground, and for that reason alone his argument is rather more difficult to follow. Moreover, he is now dealing with problems which do not appeal greatly to the man of science, who may refuse to recognise them as problems at all. He will probably assent vaguely to the saying of Petronius standing at the head of chapter 7:

> Fallunt nos oculi, vagique sensus
> Oppressa ratione mentiuntur.

The man of science may even confess that the ridiculous theory of pp. 272 and 273 is not an unfair summary of his own and his friends' views as to the nature of physical objects and their sensible appearances, but still he may be inclined to say, "Why make all this fuss about it? I know it is easy for a philosopher, with his puzzles about pennies that are 'really' round, though they 'look' elliptical, and about mirror images, and so on, to pick holes in the ordinary common-sense and scientific notion of material objects, but what does it all come to? The ordinary theory, however silly ultimately, is simple and familiar and works well in practice. The philosophical theories are not simple, there are several different ones, and there is nothing to show that they are better for ordinary purposes."

Prof. Broad has not played his cards very well in order to refute such contentions as this and induce the man of science to read on, for he has kept his best arguments for his last chapter. The argument is, briefly, that the ordinary view only works in practice by leaving out the facts that do not fit in with it. It so happens that these inconvenient facts have not, up to the present time, been important and that the man of science has been well advised to forget them and get on with his work, but this happy state of affairs may not last for ever. The history of the theory of space and time supplies the moral. The traditional theory was simple and easy to understand and worked well; the engineer and the chemist still ask for nothing better. It has only been gradually that the incompatible facts have been forced on people's attention in spite of struggles to ignore them; and some people still ask, "Why all this fuss about the principle of relativity?" The only answer is that clear ideas, if we can get them, are better than muddled ones, however comfortable. What is worth doing for space and time is also worth attempting for sense perception and material objects.

It is impossible in the course of a short notice to make any detailed criticisms of this latter part of the book; suffice to say it is the kind of thing scientific philosophers ought to write and philosophical men of science to read.

The author shows wit and erudition in his chapter headings, though he might have translated King Alfred for us. The index is full and carefully compiled. As the author shows some pedantry in the matter of authors' names and titles, it is not unfair to point out that Galileo is a Christian name, consequently there was no such person as "Galileo, G." A. D. R.

Geology in War.

(1) *The Work of the Royal Engineers in the European War, 1914–19. Work in the Field under the Engineer-in-Chief, B.E.F. Geological Work on the Western Front.* Pp. 71 + 7 plates + 19 figs. (Chatham: W. and J. Mackay and Co., Ltd., 1922.)

(2) *The Work of the Royal Engineers in the European War, 1914–19. Work in the Field in other Theatres of War. Egypt and Palestine—Water Supply.* Pp. vi + 64 + 7 maps + 10 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1921.)

IN 1914 there was no geological organisation in the British Army, though it would appear that the Germans had a definite geological establishment in connexion with each of their Armies. Very early during the War the need of geological advice was felt in connexion with the supply of water to the troops both in the battle zone and on the lines of communication, but it was not until April 1915 that a geologist was appointed, and not until the following June that he joined the staff of the Chief Engineer in France. In 1916 Lieut.-Col. Sir T. W. Edgeworth David joined the staff and eventually became Geological Adviser at G.H.Q. on matters connected with military mining. Now a permanent geological establishment is suggested.

The volume under review gives a concise account of the work carried out by the geological staff on the Western Front and is copiously illustrated by maps, sections, and photographs. The chief method of supply of water was from borings in the Upper Chalk (Senonian), and though in many cases the sites for bores were chosen for military rather than geological considerations, the maps showing the possibilities of obtaining a supply in different parts of the area were invaluable to the Army Water Supply officers. Water was also obtained from the Thanet Sands, and the various kinds of apparatus employed in boring and pumping are described in detail.

An investigation of the water-table in the Chalk was made in connexion with water supply, and the fluctuations of level were studied for the purposes of military mining and the construction of dug-outs. The importance of a thorough knowledge of geological structure in connexion with the construction of military mines is demonstrated, and details are given of several series the success of which depended on such knowledge.

Other military activities requiring the services of the geologist were the winning of road-metal, the provision of sand and aggregate for concrete, and the working of such coal mines as remained in the hands of the Allies.

The plates include a map showing by colour-washes the suitability of the country for dug-outs and others indicating the ancient excavations (" Souterrains "), which were so largely used as cover for troops in Northern France.

The second volume under notice contains an interesting account of the enormous difficulties successfully overcome by the Royal Engineers in the supply of water to the army during its advance across the Desert of Sinai from Egypt into Palestine.

The work included the laying of a pipe-line, by means of which a daily supply of 600,000 gallons of Nile water was carried to the troops in El Arish, and along the lines of communication; the transport of water in railway tanks and on camels; the development of local supplies in Beersheba and Ghaza and in the plains of Palestine, and finally the reorganisation of the water supply of Jerusalem itself.

The Antiquity of Disease.

The Antiquity of Disease. By Prof. Roy L. Moodie. (University of Chicago Science Series.) Pp. xiv+148. (Chicago: University of Chicago Press; London: Cambridge University Press, 1923.) 1.50 dollars.

Studies in the Palæopathology of Egypt. By Sir Marc Armand Ruffer. Edited by Prof. R. L. Moodie. Pp. xx+372+71 plates. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1921.) 17*s.* net.

At a time when those concerned with medical education are concentrating their endeavours as never before upon the problems of the causes and prevention of disease, a book that attempts to probe into the distant past and discover the early history of pathological processes is sure of a welcome, even if the subject is described by the wholly unnecessary and ambiguous word " palæopathology." The chief value of Prof. Roy Moodie's fascinating and well-illustrated little book is that it directs attention to the scope and interest of such studies and provides a bibliography extensive enough to start the inquirer on his way to enlightenment. The pathological conditions revealed in fossil vertebrates, and the identification of the destruction wrought in fossil bones by contemporary bacteria and fungi, prepare us to accept the evidence that bodies resembling bacteria and cocci in fossils as old as the Palæozoic are actually fossilised micro-organisms.

The part played by bacteria in remotely ancient times is as yet only a subject for speculation. " The pre-Cambrian bacteria so far known are supposed to have had an activity allied to that described by Drew for *Bacterium calcis* and other marine calcium-precipitating bacteria." "The results of infection by bacteria are not definitely known prior to the Permian. Bacteria and fungi, possibly, however, chiefly those of decay, are widely distributed and well known from the Carboniferous rocks. Here lies a wide field of research, although a difficult one, dealing with the origin of that type of disease which is so troublesome to humanity to-day. It seems probable from present evidences that a wide distribution of the bacterial types of disease and the resulting pathology is a relatively recent phenomenon, with an antiquity of a few million years, which, when compared with the scores of millions, possibly hundreds of millions, of years which animal and plant life have existed, is a very brief time " (pp. 13 and 14).

The earlier part of the book, which deals with these interesting problems of palæontology, is very suggestive and stimulating. The latter part, dealing with early man, makes a more immediate and personal appeal and is distinguished by the same qualities of suggestiveness;

but unfortunately its accuracy cannot be trusted. The author commits many mistakes which are scarcely excusable on the part of the editor of the late Sir Armand Ruffer's works. It is natural that he should feel a deep sense of gratitude to the genial scholar whose writings directed his attention to the study of the effects of disease in ancient man; but the works of Sir Armand Ruffer give no warrant for the many misleading statements in the final chapter of this book. Hence it becomes necessary to warn readers of this chapter not to accept its statements as facts until they have been checked by reference to the standard work on the pathological conditions found in ancient Egyptian bodies, Prof. Wood Jones's statement in the Report for 1907–08 of the Archæological Survey of Nubia. It is particularly necessary to correct Prof. Moodie's misleading references to syphilis (p. 117), smallpox (p. 119), pyorrhœa (p. 126), and Pott's disease, which he says is "so common in Egypt" (p. 133), when I think he was aware of only *one* case (or at most six cases) found among thirty thousand bodies!

I refer to these blots on a very fascinating and stimulating book before such insidious errors get fully launched upon a career of diffusion. In several places in the book Prof. Moodie refers to the history of these modern investigations in the pathology of the ancient Egyptians, and as his account is quite fictitious, perhaps I might explain how they did begin. Two months after my arrival in Egypt in 1900 the late Dr. W. H. R. Rivers, who was working on the problems of colour vision in the natives of Upper Egypt, wrote directing my attention to the natural preservation of the brain in the Pre-dynastic bodies being excavated by Dr. Randall-MacIver at El Amrah. I went to Upper Egypt to study this remarkable phenomenon, and the first ancient Egyptian grave I looked into contained the skeleton of a boy who lived nearly sixty centuries ago and had suffered from stone in the bladder. I sent the specimen to Dr. Shattock at the Royal College of Surgeons, who published a report on it, and for the next seven years I devoted much of my leisure to the collection of pathological specimens from ancient graves until, in 1907, Dr. Wood Jones began his epoch-making work of making the collection now in the Museum of the Royal College of Surgeons, and writing the only trustworthy account of the pathological conditions found in Egypt and Nubia that has yet been published.

The late Sir Armand Ruffer did not begin his work until Prof. Wood Jones and I had completed ours. In 1908, having discovered a hunch-back among the mummies of the priests of Amen from Thebes, I asked the late Profs. Ferguson and Ruffer whether they could detect tubercle bacilli in his psoas abscess. This started Sir Armand on the work. In attempting to put the history of these events into their proper sequence I ought to direct attention to the real achievements of the late Sir Armand Ruffer in this field. These were, first, the perfection of the technique for the histological study of mummies; and, secondly, the discovery of the eggs of the Bilharzia worm in mummies embalmed thirty centuries ago. These results were attained only after long and wearisome experiment carried on with exceptional skill and persistence, and represent a very great achievement.

G. ELLIOT SMITH.

Our Bookshelf.

Factors affecting the Control of the Tea Mosquito Bug (Helopeltis theivora, *Waterh.*). By E. A. Andrews. Pp. iv + 260 + 44 diagrams. (London: Indian Tea Association, 21 Mincing Lane, 1923.) 3*s.* 6*d.*

THE work which Mr. E. A. Andrews has carried out in India in connexion with the mosquito bug of tea is described in this book. The limitations in the control of the pest by spraying are discussed, and an inquiry into the question of natural checks has led to the conclusion that the problem could not be solved by such means. The effects of climate and the variety of bush which is cultivated are discussed in some detail.

The action of various manures has been investigated, lime and potash manures having been shown to be of benefit. The relation of cultural operations to the severity of attack is also included. Whereas no relation is evident between the total quantities of potash and phosphoric acid present in the soil and the extent of attack, manuring experiments have yielded interesting and definite results. Immunity would seem to depend on the ratio of the available potash to the available phosphoric acid. Great benefit is derived from an increase in the available potash in the soil, the effect, however, being only transient. Analyses of the leaves show differences corresponding to those deduced from observation of the soils. Immunity has been induced experimentally by the direct introduction of potash to the plant, tea bushes so treated remaining immune for the rest of the season.

The importance of this work from an economic point of view is very great. The future of economic applied entomology lies far more in the detailed study of the relations between the insect, the plant, and the natural conditions influencing both, than in direct control by means of insecticides or entomological methods: such research, however, requires organised team work between the various branches of science. Mr. Andrews's work would be valuable if it emphasised this need alone; but it also embraces sound investigation and a great hope of the discovery of a practical control for the most serious insect pest of the tea crop.

The author is to be congratulated on his results and the patience with which he has collected his numerous data.

H. M. L.

Agriculture in the Tropics: An Elementary Treatise. By Dr. J. C. Willis. (Cambridge Biological Series.) Third edition, revised. Pp. xvi+223+24 plates. (Cambridge: At the University Press, 1922.) 12*s.* 6*d.* net.

DR. WILLIS'S book was intended, not as a practical guide in field methods for the tropical agriculturist, but to serve mainly as an introduction to the study of the leading economic principles governing the modern practice of agriculture and planting in the tropics. With the remarkable developments taking place in tropical agriculture, such a book will require periodical revision to keep abreast of the times. The second edition was published in 1914, and the call for the present (third) issue has afforded a further opportunity for revision. It is a pity that no preface to the new edition has been printed, and, except for special information supplied by the publishers for the convenience of the reviewer, it would be difficult to trace new matter or corrections.

No important re-arrangement of the book has been adopted. The four parts remain the same and the slight revisions made in them are neither numerous nor very important. There are still opportunities, however, for improvement in the text. In dealing with the West African oil-palm (*Elæis guineensis*) due reference is made to the recent planting of the palm in the East, but the student would gather very little as to the origin of the "pericarp" oil (not mentioned as such) from the account given; while the statement that "of late another oil has been obtained from the seeds of the palm" is a little naïve. Definite reference also should be made to the wide use of coco-nut oil for the manufacture of margarine. Further, as regards gingelly oil, while it may be true that comparatively little of the oil is exported from the countries of production, the statement should be completed by reference to the important export of the seed for oil extraction in Europe.

The book remains, however, an excellent introduction to a subject of great and increasing importance, and should be read by all interested in the practice and administration of tropical agriculture and planting.

Crystallisation of Metals: being a Course of Advanced Lectures in Metallurgy delivered at the Royal School of Mines, Imperial College, under the Auspices of the University of London, in February and March 1922. By Col. N. T. Belaiew. Pp. 143+21 plates. (London: University of London Press, Ltd., n.d.) 7*s.* 6*d.* net.

COLONEL BELAIEW has written a book on the "Crystallisation of Metals," which is remarkable in that it deals with the coarse structure rather than the microstructure of metals. It is therefore noteworthy that a great many of his illustrations are natural size, while others are ×2, 5, or 10. Only in rare instances are higher magnifications used, although in certain extreme cases remarkable pictures are given in which the magnification is as high as 4500. At the other extreme, two illustrations are given on a *reduced* scale (×½) of Tschernoff's famous crystal, more than fifteen inches in length, which was found in the upper portion of the pipe in the sinking head of an ingot of soft open-hearth steel weighing about 100 tons. The final paragraphs of the book deal with the structure of Damascene steel, and include two beautiful illustrations, of approximately natural size, of Damascene blades, as well as microphotographs with an enlargement of 1000 diameters. The little book forms an admirable supplement to existing treatises on metallography, and reaches a level which entitles it to a place among standard works on this subject.

Visual Illusions: their Causes, Characteristics, and Applications. By M. Luckiesh. Pp. ix+252. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 15*s.* net.

IN this book Mr. Luckiesh presents one hundred illustrations of familiar and little-known optical illusions, round which the text is written. On account of the great complexity of the subject, the author confines himself to static illusions, and dispenses to a large extent with theory. It is inevitable that there should be some overlapping in any classification of visual illusions, since not seldom more than one factor enters into them; but the arrangement or grouping together in the various chapters which is adopted in the book is a convenient and practical one. After chapters on the eye and vision, geometrical and depth, or distance, illusions are considered in detail. These are followed by illusions due to irradiation, colour, and lighting. A special chapter is added on natural illusions, such as the apparent size of the setting sun as compared with the sun at the zenith, the magnification of objects seen through fog, and mirage. The last four chapters are devoted to applications of the natural principles of visual illusions to practical purposes, in the shape of painting, decoration, architecture, and camouflage. The book is well written and attractively produced, and should be of interest to others as well as to students of psychology.

Geology. By C. I. Gardiner. (Science for All Series.) Pp. x+138. (London: J. Murray, 1923.) 3*s.* 6*d.*

IN 1914, Mr. Gardiner produced his "Introduction to Geology" (see NATURE, vol. 94, p. 362), in which he found more scope for originality than is given by this smaller volume. The conception of a work on geology "for all" must vary with the outlook of the author, and Mr. Gardiner has had long experience in the training of beginners in the region where the foundations of stratigraphical geology were laid within the British Isles. We cannot help thinking that "all" would like to hear something of the Laurentian cauldrons in which the oldest strata of Canada were immersed; of the rich fauna of the Olenellus-beds; of the coming of the race of reptiles that was so long to dominate the world; and of the amazing development of mammals, from South Dakota and the Paris Basin to the Trinil river-bank in Java. But Mr. Gardiner knows well that a fossil picked up in a Gloucestershire lane or from a talus in the Isle of Wight may loom more largely than Atlantosaurus or the titanotheres. All reputable English text-books insist upon the Woolhope Limestone and the Thanet Sands. That we cannot escape from them in so small a volume is no sign of Mr. Gardiner's personal limitations. His style is always clear, and throughout he is in touch with recent observations.

G. A. J. C.

Letters to the Editor.

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

The Mechanical Equivalent of Heat.

WITH the assistance first of Dr. J. K. Roberts, now of the National Physical Laboratory, and later of Mr. E. O. Hercus, I have been engaged for some years upon a determination of the mechanical equivalent of heat. It is believed that an indication of the lines upon which the experiment is being made may be of use to other workers in this branch of physics.

A number of determinations of what may be called the electrical equivalent of heat have been made, including the very thorough work of Jaeger and Steinwehr at the Reichsanstalt, but since the time of Joule the only direct measurements of the mechanical equivalent of heat are those of Rowland published in 1880 and of Reynolds and Moorby. The work of the former has for long been regarded as of high accuracy. Reynolds and Moorby's result is in terms of the mean calorie, and there is considerable room for doubt as to the value of that calorie in terms of the 15° or the 20° calorie. This doubt arises from the conflicting values found for the specific heat of water from, say, 60° to 100° C. It appeared, then, to be desirable to have a direct determination of the mechanical equivalent of sufficient accuracy as to be available for comparison with the electrical equivalent of heat. Such a comparison may throw light on the absolute values of the electrical units. It must be admitted, however, that to obtain the necessary accuracy in the value of the mechanical equivalent for that purpose will be a problem of some difficulty. But there appears to be no reason, if the same attention is given to the question as has been given to the realisation of the electrical units, why it should not be attained.

In our experiment, work is indirectly converted into heat; the work done and the heat developed are directly measured. The work is found, as in Rowland's experiment, in terms of a couple and a number of revolutions; the heat is measured by a continuous flow calorimeter in terms of a quantity of water and its rise of temperature. A correction is made for the heat lost during an experiment. The relation between these quantities is

$$2\pi nmgd = Jw(t_2 - t_1) + L$$

where J ergs per calorie is the mechanical equivalent of heat. The apparatus is designed so that the heat lost can either be directly determined, or be eliminated by taking the difference between the equations for a heavy and a light run.

The efficiency of an apparatus for finding the electrical or the mechanical equivalent of heat, which may be briefly called a J apparatus, is expressed by two characteristics, namely, (1) the percentage of the heat developed which is lost, and (2) the accuracy with which the lost heat can be determined, or eliminated from the expression for J.

We have gradually developed, after many failures, an apparatus which, measured by this test, is an efficient one. We set out in the following table average figures for the power absorbed, and the percentage of heat lost in experiments by the observers named:

Observer.	Power.	Percentage of Heat lost.
Rowland	0·4 H.P.	3
Callendar and Barnes .	0·03 ,,	2
Reynolds and Moorby .	70 ,,	0·8
Laby and Hercus . .	0·2 ,,	about 0·2

Any apparatus for the direct determination of J is a brake dynamometer. Reynolds and Moorby, for example, used the Froude hydraulic brake, which is the same in principle as the devices used by Joule and by Rowland, but the design is more efficient. We

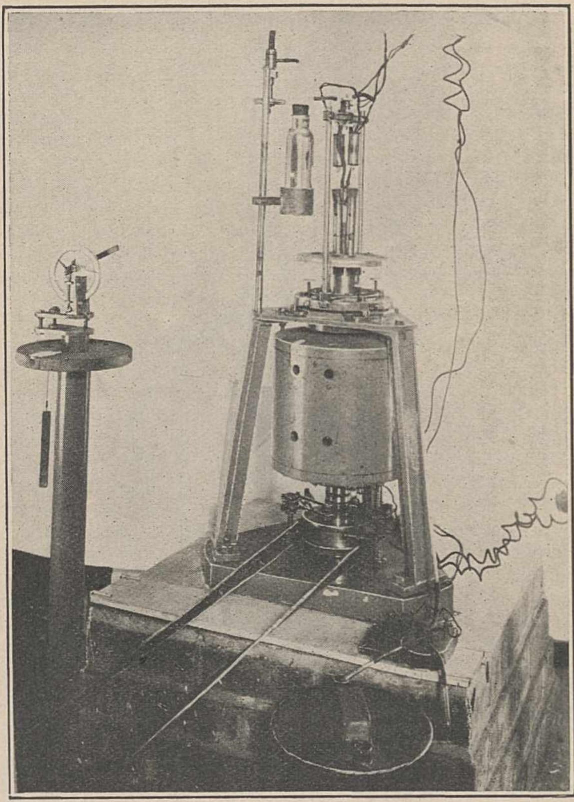


FIG. 1.

decided to enclose the brake in a vacuum flask, in order to obtain high thermal insulation, and to use continuous flow calorimetry. The brake we are using is an electro-magnetic induction brake, which is closely analogous to an induction motor. The construction of the brake is shown in Figs. 1 and 2. An electromagnet (see Fig. 2) rotates about a vertical axis; in the rotating magnetic field so produced a copper cylinder (Fig. 2) and an iron core are placed. The copper and iron cylinders are attached by means of a glass tube to the inner sleeve of a bearing. This part of the apparatus is called the stator. The rotating magnetic field induces eddy currents in the copper cylinder, which is thereby heated, and the reaction between these currents and the rotating field causes a couple to act on the stator.

The couple acting on the stator is balanced by the tensions in two wires attached to the torsion wheel carrying two weights, one of which is shown at the left of Fig. 1. The only details which need be mentioned of this part of the apparatus are the devices used to reduce friction. The bearing (Fig. 2) is a parallel ball-bearing for which the friction is less than 1/10,000 of the couple acting on the stator. To eliminate friction, the wheels over which the above-mentioned wires pass are carried on steel knife-edges resting on hardened steel planes.

For the temperature measurements we use platinum thermometers which are connected differentially to a Wheatstone bridge made to Müller's design. During the course of a year the average variation of the fundamental interval from its mean value has been 1/20,000 for one thermometer and 1/80,000 for the other. This would imply that the thermometry is of satisfactory accuracy.

The evaluation of the heat lost has proved far the most difficult part of the experiment.

In the earlier designs the loss in some experiments

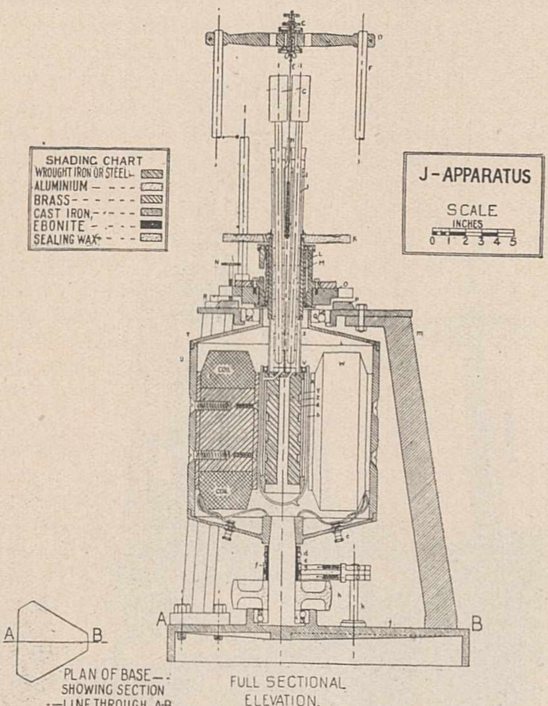


FIG. 2.

was as high as 2 per cent of the heat developed. All attempts to determine it correctly, or to eliminate it by taking the difference between a heavy and a light experiment failed, for reasons which cannot be given here. To overcome this difficulty the calorimeter system was reconstructed, by bringing the thermometers close to the vacuum flask and highly insulating them, as shown in the accompanying figures. This has reduced the heat loss to about 1/10 of its previous value. Means have been provided for determining the loss, and the stator is being modified so that the loss may be eliminated in the usual manner in continuous flow calorimetry by taking the difference between a heavy and a light experiment. It is expected that this alteration will increase the heat developed, and so reduce the percentage of heat lost still further.

T. H. LABY.

University of Melbourne, April 4.

The Transformation of Electronic into Electro-Magnetic Energy.

THE fundamental propositions given below, which do not refer to the excitation of characteristic but to that of the ordinary rays which have been called "independent" X-rays, have sufficient experimental evidence supporting them to justify the following statements so that they may serve as guiding principles for further investigations.

1. When a definite number of electrons in motion (cathode or β-particles) of definite velocity traverse very thin layers of different substances, the average fraction of their energy transformed into that of electromagnetic radiation (X- or γ-rays) is, per atom of any one substance, proportional to the square of its atomic number.

2. In these circumstances, for a given layer, the energy so transformed depends only on the mass per unit area of the layer and on the number of cathode or β-particles traversing it, being independent of their velocity.

By a very thin layer is meant one so thin that the ratio of the number of particles emerging from the layer to the number entering it is very nearly equal to unity.

The reason for the above statement is as follows. If cathode or β-particles of definite type and of total energy E traverse a layer of a substance of unit area and mass dm, the energy of the X-rays formed in the layer may be written as $\lambda E \, . \, dm$. We call λ the mass transformation coefficient. The atomic transformation coefficient, α say, is then obtained by multiplying λ by A/N, where A is the atomic weight and N is the number of atoms in a gram of hydrogen. I find that α, which gives the average fraction of the energy transformed per atom, varies approximately as the square of the atomic number Z, while λ varies as Z^2/A and both α and λ vary inversely as the energy of a single bombarding particle. Hence the above propositions hold approximately, since the total energy E is proportional to the energy of a single particle and their number n, so that $\lambda E \, . \, dm$ varies as $n \, . \, dm$.

With respect to the physical processes underlying the excitation of "independent" X-rays, certain considerations incline me to the provisional view that these X-rays are produced by a collision or by close interaction between the cathode or β-particles and the actual nuclei of the atoms rather than with the electrons surrounding them.

J. A. GRAY.

McGill University, Montreal,
May 21.

Dr. Kammerer's Alytes.

PROF. MACBRIDE's letter in NATURE of June 23, p. 841, did not at first seem to require any rejoinder. But I find that some botanists, and perhaps others unfamiliar with zoological terms, suppose that the quotations from Boulenger contradict my statement that rugosities are not formed on the palmar surfaces. Boulenger, of course with perfect accuracy, states that rugosities in various genera appear on the *inner* side of the digits (italicised by Prof. MacBride). This is the *radial* side, as emphasised in both our letters, not the palmar surface, which was the part which bore the extraordinary structure visible in Dr. Kammerer's specimen.

W. BATESON.

June 24.

The Breeding Period of *Echinus miliaris*.

THE breeding period of the sea-urchin, *Echinus miliaris*, is very interesting from many points of view; and especially as this animal readily yields ripe eggs and sperm with which to carry out artificial fertilisation in inland laboratories for the observation of fertilisation, segmentation and gastrulation stages in the living state. The records made at this laboratory down to 1919 showed that *E. miliaris* has been found to breed from about February-March to August. In 1920 I arrived at the conclusion that certain marine animals, such as the oyster, breed continuously so long as the sea-temperature remains above a definite temperature, providing the general biological conditions are otherwise normal. On this view, and if the type of breeding in *E. miliaris* were the same as that of the oyster, the breeding period of this sea-urchin should be found to extend to about November-December, on the average.

In March and April 1920 many successful artificial fertilisations of *E. miliaris* were made, and it may be assumed that similar successful fertilisations could have been obtained onwards to August. After August periodical collections of this urchin were made *from the shore* to test the view mentioned above. On September 14 the proportion of ripe individuals collected was high and six excellent artificial fertilisations made; on October 13 the proportion of ripe individuals collected was smaller, but good fertilisations were still obtained, and on October 29, although the proportion of ripe individuals was now lower, an optimum fertilisation was obtained yielding very fine and healthy plutei on November 1. The observations at Plymouth were interrupted at this time, but on November 3 a high proportion of *E. miliaris* which had been *dredged* from the oyster beds off Whitstable were found to be ripe and yielded healthy larvæ, which lived in some bowls as plutei until at least January 5, 1921. A batch of similar urchins forwarded to Plymouth yielded an excellent fertilisation on November 10,[1] and although no fertilisation was made later, it was observed at various times during the winter that the gonads of Whitstable specimens examined remained full. A sample of urchins examined at Plymouth on January 26, 1921, showed that a small proportion of ripe males with full gonads still occurred but no ripe female was found, and the big variation in size of the gonad observed in the remainder of this sample points to a distinct physiological difference between the Plymouth and Whitstable groups.

It is thus clear that successful artificial fertilisations of *E. miliaris* may be obtained from Plymouth specimens during about the period February-March to November, and that the breeding period in the south of England may be considered to extend over the same range, but it is nevertheless open to doubt whether the capacity to yield a successful fertilisation may be good evidence that a species is breeding.

The fact that breeding individuals may be obtained over such a long period of the year affords good reason to believe that single individuals may spawn several times a year, but there is no evidence that collective spawning occurs in this species at one given phase of the lunar cycle such as Fox found to be the case in the Mediterranean sea-urchin *Diadema setasum* (see NATURE, February 23, 1922). In three collections of *E. miliaris* from Looe Is. near Plymouth, on September 23, October 12, and October 28 respectively, the unripe individuals showed variation in the size of the gonad ranging from about 1/12 to a full gonad. These observations do not, however, rule out the possibility of spawning occurring normally—in those individuals which are ripe—at certain definite phases of the lunar cycle, for example, after any low-water springs; for it has been observed not infrequently that ripe specimens collected at low-water spawn before arriving at the laboratory.

The sex-conditions in the collection of *E. miliaris* mentioned above were examined closely for any appearances indicating sex-change; for a condition of sex-change in sea-urchins may be regarded as a possibility in view of Mortensen's discovery of the common occurrence of protandric hermaphroditism in ophiuroids and of Fox's observation referred to above but not known at that time of the very rapid (monthly) filling and emptying of the gonads in the sea-urchin, Diadema: it is also worthy of note that Gray (Proc. Camb. Phil. Soc., xx. pt. 4, 1921) has described isolated cases of apparent and true hermaphroditism in the sea-urchins Arbacia and Strongylocentrotus. In *Echinus miliaris*, however, no definite hermaphrodites were found, but in several gonads at about the period of change from the spent condition to the rematuring stage, a small quantity of sperm was found together with gonocytes apparently too large for spermatocytes, and gonads were found having a colour generally associated with one sex but with young sex-elements of the other sex. The female gonad in *E. miliaris* varies in colour from white when young to yellow or orange when mature, whereas the male gonad varies from brown to grey. These differences of colour are undoubtedly an outward expression of the differences in metabolism in the sexes leading up to—or consequent upon—the production of mature sex-elements.

A similar sexual colour difference is observable in the gonad of other animals; for example, in *Crepidula fornicata* the gonad in the male stage is brownish red but yellow in the female, while that of the hermaphrodite stage is orange, and it has already been shown (Orton, Proc. Roy. Soc., vol. 81, B, 1909) that in the case of Crepidula the primary sexual characters precede in development and forecast the appearance of the secondary sexual characters. Thus the colour of the gonad in animals is undoubtedly closely connected with deep-seated changes—probably induced by sex-hormones or, as Geoffrey Smith visualised them, sexual formative substances—which are different for the mature male and female condition, and apparently also for a potential condition of sex while sex is yet unrecognisable in the primary sex-elements.

It would, therefore, seem possible that a chemical test might be devised to detect a sex-potentiality in an undifferentiated gonad. Such a test if obtained would be a very valuable help in investigating suspected cases of sex-change, especially in cases where a change-over of sex may occur between successive periods of growth of the gonad as is possible in *Echinus miliaris*, *Mytilus edulis*, and other animals, but more probable in the case of the common limpet, *Patella vulgata*. In this kind of sex-change the residual sex-elements in a gonad would often give a clue to the recent sex-condition, while the chemical test would provide evidence of the forthcoming or potential sex-condition.

The rapid change-over of sex in the oyster is also very strongly suggestive of the existence of a sex-hormone, as the gonad in a female-functioning oyster normally changes over quite suddenly after the extrusion of the ripe ova to the production of male elements only. There is good ground, therefore, for looking for a chemical test for sex-potentiality, especially in invertebrates, and there is no doubt that our knowledge of sex-conditions would increase rapidly after the discovery of such a test.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, May 24.

[1] This fertilisation and the one at Plymouth on October 29 were made by Mr. A. J. Smith. The larvæ from the Whitstable urchins November 3, and the Plymouth ones October 29, showed a fine apical tuft of cilia, which appears not to have been recorded in *E. miliaris*, although MacBride has described a similar tuft in *E. esculentus*.

An Einstein Paradox.

THE letter with the above title in NATURE of June 2, p. 742, contained two oversights which I should like to be allowed to correct.

1. In the second part I inadvertently changed the meaning of x'. Overlooking the fact that x' in the first part meant, by implication, the distance of K_1 from L at the time that the light reached him, I used it in the second part as the distance K_1L at the instant the signal was given. I should have employed a different letter, x_1; and then, if required, $x' = c/(c+v)$ of x_1.

2. A term was omitted from the value of x', which should have been $(1+v/c)x - vt$.

R. W. GENESE.

40 London Road, Southborough,
June 13.

The Concilium Bibliographicum.

MY attention has been directed to a statement in NATURE of April 28, p. 584, made in connexion with the report of a meeting concerning the "Zoological Record." It is stated that "With the exception of the 'Archiv für Naturgeschichte,' which is about nine years behindhand and consequently of very little use, the 'Zoological Record' is at present the only bibliographic guide to zoological literature being published in the whole world."

Permit me to recall that the Concilium Bibliographicum at Zurich, founded in 1895 by Dr. Herbert Haviland Field and approved by the International Zoological Congress, is still continuing his work. After Dr. Field's death in 1921, the Concilium was placed under the auspices of the Swiss Society of Natural Sciences and the United States National Research Council, and has published since that time volumes 30 and 31 of the "Bibliographia Zoologica," containing an international review of zoological papers. Two other volumes (32 and 33) are already in progress of publication.

J. STROHL,
Director of the Concilium
Bibliographicum.

49 Hofstrasse, Zurich,
May 15.

[We have also received a letter from Messrs. Louis B. Prout and George Talbot, of the Hill Museum, Witley. They suggest the issue of cards so that "subscribers would have the current literature available say every month, and no one would be obliged to purchase sections which would not be useful to him." They too direct attention to the reorganisation of the Concilium Bibliographicum and strongly urge co-operation with it.

Zoologists will be glad to learn that the Concilium Bibliographicum is still in being. There was some excuse for the incorrect statement to which Dr. Strohl objects, for inquiry at the two chief zoological libraries in London has failed to produce a volume of "Bibliographia Zoologica" later than vol. xxx., which, though it purports to deal with the literature down to the end of 1920, is mainly composed of titles from 1915–1917; it also omits Lepidoptera, Hymenoptera, and Vertebrata. But, even were "Bibliographia Zoologica" more up-to-date, more complete, and more accessible, its plan scarcely enables it to compete with the "Zoological Record" for the support of systematists. In the past the peculiar contribution of the Concilium has been the separate cards, but we have not seen any of these for a long time. We hope their issue has not ceased, for it is along those lines that co-operation seems most promising. If the Concilium could furnish the titles completely and promptly, the Zoological Recorders could work up the analytical index they have been accustomed to provide. We may remind Messrs. Prout and Talbot that the several sections of the "Zoological Record" have been sold separately for the past twenty years.—ED. NATURE.]

Educational Problems of Tropical Agriculture.

IT is exceedingly important at the present moment that the attention of men of science should be directed to some of the needs and problems connected with tropical agricultural education. As many readers of NATURE are aware, a college of tropical agriculture, the only one of its kind with pretensions to University standing within the Empire, was opened last year in Trinidad, and the ultimate success of this institution, both from the point of view of education and research, will, quite irrespective of financial support, depend upon the institution's outlook and policy and, what is equally important, the degree of acceptance which this receives in Great Britain and America.

In England agricultural colleges have not, from an academic point of view, achieved a very high status; nor have they been free from adverse criticism on the part of practical farmers. The policy of the institutions, therefore, has been somewhat unstable, tending to oscillate between the solar force of the universities and the lunar attraction of the practical farmers. This condition has been produced through misunderstandings on the following points: (*a*) the nature of agriculture; (*b*) the definition of the word "practical"; and (*c*) the difference between education and instruction.

Agriculture is to some extent an art and to some extent a profession, but fundamentally and comprehensively it is a business, or, if another term be preferred, it is biological industry. The trouble has been that most students of agriculture have thought of it as a profession, whereas the practical farmers have regarded it as an art. By definition, both are wrong fundamentally. Unenlightened, the students have tended to specialise in applied natural science (often of questionable quality), while the farmers have been the advocates of concentration on the art ("real practical work"). The misunderstanding as to the word "practical" is, therefore, clear. Neither is practical; for agriculture is fundamentally economics, in which faculty practical work can be purely intellectual, for example, accountancy and statistical inquiry. Misconceptions as to the meaning of practical have been responsible for confusion as to the difference between education and instruction. The word instruction should be relegated with patent rights to the Army, Navy, and Police Force. Except as connoting the routine of one person telling or showing something to another, it means nothing and leads to nothing. Education implies understanding and a training of the faculties including the practical instincts. Instruction alone is useful for those who do not want to be, or are incapable of being, educated; but matriculated students, such as one now finds in agricultural colleges, ought to be anxious for, and capable of, some education.

In the tropics, the so-called agricultural education of the past has been little more than instruction. A youth has been instructed how to read a polariscope or do a Babcock test—and becomes a chemist! Another is taught to bud oranges or run a sugar mill, and becomes a planter. This has suited the tropical temperament and climate, and in most cases, it is to be feared, the average type of mentality. But if tropical agriculture is to advance we must aim at, and insist upon, higher standards. The planter of the future must be taught to think and to understand his economic and biological universe. This is realised at the West Indian Agricultural College, but are we going to live up to it? Will such an outlook receive the support of tropical public opinion on which we are so largely dependent for funds? Is it, for the present, to be expected? It is therefore important that the matter should be appreciated by scientific opinion in this country to which scientific workers in the Crown Colonies look very largely for encouragement and protection.

Reference to research has been purposely avoided in the above observations for the sake of simplicity. But research, the mother of scientific education, has also its disabilities in the tropics. Up till quite recently, the demand, the popular demand, has been for "trouble-curing" rather than research. The present danger, however, is that research work may be interfered with through depriving investigators of their time in order that they may give instruction.

W. R. DUNLOP.

West Indian Agricultural College,
14 Trinity Square, E.C.3.

Gravitation and Light-Pressure in Nebulæ.

IN NATURE of June 16 there is a most interesting letter by Dr. Jeans on my suggestion that spiral nebulæ may consist of dust repelled from the stars by light-pressure. My original note must, I fear, have been somewhat misleading to have called forth the particular criticism which Dr. Jeans's letter contains. As was, I think, brought out in the discussion at the Royal Astronomical Society, it was never my intention to suggest that the dust clouds are so thick that there is any appreciable shielding; indeed it is perfectly obvious, as Dr. Jeans points out, that the whole theory would break down unless the particles are assumed to be so far apart that they can be treated individually.

The misunderstanding is due to a somewhat ambiguous sentence at the end of the paper, which I admit is capable of giving quite a wrong impression. I had anticipated that my suggestion would be criticised unless I presented some explanation of the so-called "novæ" in spirals. The suggestion put forward was that they were similar to terrestrial meteoritic showers. In order to show that this was not impossible I put in some very rough quantities, and endeavoured to show that they would not lead to absurd results for the characteristics of the nebula. The density found, based, it may be remarked, upon the time in which the meteoritic stones are supposed to evaporate, leads to a mass over the depth of one light-year of 0·1 grams per square centimetre. I agree, of course, that this cannot be supported by radiation pressure; indeed a remark by me to the same effect may be found in the *Observatory* some years ago. It would have been better had I said that this result was some 10^3 times too high in view of the obvious transparency of parts of the spirals. The great uncertainty of the quantities used, however, emboldened me to say this was of the right order of magnitude; compared with the results derived from other hypotheses to account for the "novæ," which led to results 10^6 times greater, this was perhaps excusable.

Dr. Jeans's criticism, to which I admit my somewhat optimistic sentence laid me open, applies, therefore, to that part of my paper from which this unduly large mass was derived; *i.e.* the hypotheses introduced to account for the "novæ." It is possible that the quantities which I used might be altered plausibly to give a more acceptable value. It is perhaps even more likely that a more satisfactory hypothesis may be evolved to account for the phenomenon. But the main outlines of my suggestion do not seem to be controverted.

F. A. LINDEMANN.

Clarendon Laboratory, Oxford,
June 16.

The Heape and Grylls Rapid Cinema.

OWING to arrangements deemed necessary at the Soirée of the Royal Society on June 20, I was unfortunately deprived of the opportunity I had hoped there to gain, of making a personal explanation which is important to me and which I beg to be allowed to make in NATURE.

The conception of devising a camera wherewith photographs could be taken at the rate of 5000 a sec. occurred to me in consequence of some chance remarks made to me by an official of one of the great armament-producing companies in this country. The lion's share of credit for the successful completion of the design of the camera, however, is due to my friend Mr. Horace B. Grylls, who became partner with me in this adventure in 1914; while both of us are indebted to my friend Prof. Boys, who, as all who know him will readily believe, gave us with both hands all the help and advice he had to give.

The interest which has lately been aroused by the exhibition of some of the films I took while the machine was still in Messrs. Thos. Cooke and Sons' workshop in York—experimental films and far from perfect, I regret to say—calls for some such statement as I now, with great satisfaction, make here.

WALTER HEAPE.

Manor Lodge, Tunbridge Wells,
June 21.

Adsorption and Hæmoglobin.

SIR WILLIAM BAYLISS has pointed out, in NATURE for May 19, p. 666, that he is unable to find any account of experiments on the dissociation curve of hæmoglobin at gas pressures considerably greater than that at which the hæmoglobin is presumed to be saturated. He seems to imply that there is no proof that hæmoglobin cannot take up more gas than is required by the theory that a chemical compound is formed, in which one molecule of O_2 or CO corresponds to one atom of iron.

The point is important, not only as evidence on the relative merits of the chemical and adsorption theories, but also because experimental methods of determining the oxygen dissociation curve depend on the assumption that hæmoglobin becomes completely saturated, in contact with air, at the ordinary temperature of the laboratory.

I have tried to test this question by shaking equal samples of the same blood (partly reduced) in the Barcroft differential apparatus, (1) with the bottle filled with air in the ordinary way, and (2) with the bottle filled with a mixture of air and CO, containing rather more than half an atmosphere of CO.

It is known that hæmoglobin takes up CO more than 200 times as readily as oxygen, so the effective gas pressures in the two cases were in the ratio of at least 500 : 1. If the hæmoglobin takes up gas by adsorption, one would expect to find appreciably more CO taken up than oxygen. As a matter of fact, a little more CO was taken up, but only that quantity which is accounted for by the difference of solubility of CO and air in the liquids present (blood and dilute sodium carbonate solution).

There was no evidence that the hæmoglobin itself took up any more CO than oxygen, in spite of the great difference between the effective concentrations of the two gases.

Sir William Bayliss also asks for experimental tests of the assumption that oxyhæmoglobin is a stronger acid than hæmoglobin itself. The limitations of the hydrogen electrode make the measurement of the hydrogen-ion concentration of hæmoglobin solutions, in the presence of oxygen, a difficult problem. I have been able to show, however, that if gas is boiled off in a vacuum from dialysed hæmoglobin solution, the electrical conductivity of the solution is considerably increased by shaking with oxygen or CO. (Precautions have, of course, been taken to exclude the possibility of the increased conductivity being due to impurities in the gas used.)

While this is naturally not a proof that combination with oxygen increases the acid dissociation constant of hæmoglobin, it is nevertheless the result to be expected if this be the case, and is a fact to be explained by any theory, chemical or physical.

Prof. Hill and I have pointed out that the divergent results of investigators of the heat of combination of oxygen and hæmoglobin may be due partly to bacterial action, and (in experiments on blood) partly to failure to allow for the heat changes involved when oxyhæmoglobin turns out CO_2 from carbonates. By eliminating these sources of error we have been able to get quite consistent results in experiments on defibrinated blood.

Without making any assumptions other than the recognised laws of chemical combination and chemical equilibria, it is possible to explain the behaviour of hæmoglobin by regarding its reactions with CO and oxygen as purely chemical. Sir William Bayliss has said that he doubts whether it is justifiable to apply these laws to a system in which the number of the phases may be uncertain. Surely the best way to decide this is by results, and, judging by results, the chemical theory has amply justified its position as a fruitful working hypothesis.

Can the adsorption theory explain the phenomena so completely, with so few untested assumptions? Since the paper by Wo. Ostwald in 1908, no attempt has been made, so far as I am aware, to put forward a complete theory of the reactions of hæmoglobin as adsorption phenomena. Much experimental work has been done since then, and until such a theory is put forward it is difficult to weigh up satisfactorily the merits of the two views.

At present the adsorption theory is in danger of going by default.

W. E. L. BROWN.
Physiology Department,
University of Manchester, June 4.

A Puzzle Paper Band.

AN easy solution of the paper-band puzzle described by Prof. C. V. Boys in NATURE of June 9, p. 774, is obtained as follows: Hold the hand with thumb up and palm towards you; place the paper band over the index finger, letting the ends hang down. Observe which way the original four half-twists were applied. Treat the nearest of these to the index finger on the palm side of the hand as if it were that of an ordinary single half-twist band; which complete, by looping up one-half of the band over the finger (the other twists being pushed out of the way into the remaining half). Then apply the surfaces one upon another at the finger; and turn the other half of the band inside out so as to get rid of two of the twists. It will be found to fit exactly upon the first half, as required.

ANNIE D. BETTS.
Hill House, Camberley, Surrey, June 11.

Paradromic Rings.

PROF. C. V. BOYS, in his letter "A Puzzle Paper Band" in NATURE of June 9, p. 774, gives scant credit to the geometers. Forty years ago they described the endless band of paper with a half-turn twist in it, and found that if cut down the middle line it gave a single endless band with four half-twists. But they were so obsessed, he says, with the consequence of cutting down the middle line that they missed the result he now describes. This consists in taking a band with four half-twists and converting it by manipulation into a half-twist band of double thickness.

But the difference between the known result and the proposed novelty seems not more than trivial: for if the medially cut band has its adjacent half-widths simply slid sideways, one over the other, along the entire length of the band, the double-thickness band of half-width is at once produced. Or, reversely, if the pulleys of Prof. Boys are made twice as wide, and the outer band is teased sideways at its entry on to each revolving pulley, the two halves of the band will presently come edge to edge throughout and are then seen to be nothing but the half-twist band medially cut.

As regards this lateral shifting, it is obvious that any endless band, however much twisted and knotted, may, when cut down the middle, be continuously "shuffled," in the way in which a "pack" consisting of only two cards may be shuffled. Each neighbour slides over the other in perpetual oscillatory contact, alternately face to face and edge to edge. Two different superpositions and two different edge-to-edge positions occur alternately and cyclically. In particular, the band with four half-twists may be arranged as a two-ply half-twist not in one way only but in either of two ways. For either of the two different faces of the former may be completely exposed or completely concealed in the latter.

The sheer puzzle of the manipulation Prof. Boys plans to make even harder by varying the sense of the twists, as right-handed or left-handed. I should propose (somewhat on behalf of the geometers) to escape this difficulty by letting the paper discriminate for itself. The instructions would be these. Strip the band along, two-handedly, until the twists are concentrated on a short section. They come to form roughly a circular cylinder, showing two turns of a ribbon screw. Take two adjacent widths, touching helically edge-to-edge at any point, and fold them together as if closing an open book. Then feed the short circuit at the expense of the long loop until they come equal, and fit together by stripping. These operations may quite easily be done blindfold.

Prof. Boys says that the double band shows only two of the half-turns, and that it is amusing to find where the other two have gone. But this is *vieux jeu*: for Tait explained it in his first paper on "Knots" in 1877; and he was only following Listing, who had these things clear in his "Topologie" of 1847. If the paradox is still alive it may be reinforced, for those who do not know that torsion and curvature are convertible; for the double-twist may be hung over one finger as a festoon of three equal loops, with the six pendant planes all (approximately) parallel to the finger, and then not merely half but the whole of the twist appears to have gone.

In a parenthetic confession Prof. Boys admits that he made his discovery while lying awake one night; but this may almost be interpreted as an indirect testimonial to the day labourers.

G. T. BENNETT.
Emmanuel College, Cambridge, June 12.

Chemical Symbols and Formulæ.[1]

By Sir JAMES WALKER, F.R.S.

SYMBOLS are both an aid and an obstacle to thought. Their brevity and simplicity may help us, working according to a fixed system, to perform mental operations which without their aid might be practically impossible. Their generality too may, as in algebra, enable us to solve thousands of problems in one. On the other hand, we sometimes find in science a system of symbols which, at first of great value, may in virtue of its very success so warp our thought or limit our mental outlook as to constitute a real hindrance to scientific progress. There is always the danger, arising from our familiar and constant use of the symbol, either of forgetting what it properly symbolises, or of confusing the symbol with the thing symbolised.

The function of the symbol is a practical one; in Mach's phrase, it is to effect economy of thought, and it is precisely because mankind at large is so economical of thought that the dangers of symbolism originate. The danger, however, must be faced by the student of chemical science, for without symbols systematic advance is impossible: the symbols are based on a theory and permit the representation of that theory in detail.

If we examine the practical requirement of a satisfactory system of symbols, we shall find that the system must be simple in itself and simple to operate. Consider the Roman schoolboy confronted with the problem of multiplying MCMXXIII by CXLIV. The system of notation is not too complicated, but to operate with it is practically impossible. To perform his task he must abandon the symbolism and have recourse to concrete objects—the fingers or an abacus. The Arabic notation, on the other hand, with its consistent valuation by position and the introduction of a symbol for zero, enables us, once we have passed the barriers of the addition and multiplication tables, to perform arithmetical calculations of all kinds with ease and speed. It is simple in itself and simple to operate.

The same requirements are essential to a system of chemical symbols. The first symbols, those for the metals known to the ancients, indicated nothing but their supposed association with the planets and the gods ruling them. Thus the solar disk stood for gold, the lunar crescent for silver, the mirror of Venus for the Cyprian metal copper, and so on. Towards the end of the eighteenth century we see the beginnings of our present system of elementary symbols. Hassenfratz and Adet (1787) used for the non-metals straight and curved lines which could be combined together (much as in phonetic shorthand) to represent the qualitative composition of compounds. The symbol for a metal was a circle, and to distinguish one metal from another the initial of its Latin name was written within the circle—thus (Sb) was the symbol for antimony.

Dalton used for metals and non-metals alike only circular symbols, doubtless to represent spherical atoms, and in his hands the symbols assumed a quantitative significance based upon his atomic theory. For the simple non-metals these symbols were arbitrarily chosen, ○ representing an atom of oxygen, ⊙ an atom of hydrogen, ⦶ an atom of nitrogen, and so on. For the metals he adopted the same device as Hassenfratz and Adet, using, however, the English instead of the Latin names, so that for example Ⓛ represented an atom of lead. Compounds could be represented by the juxtaposition of the elementary symbols, which now gave, not only the qualitative, but also the quantitative composition of the compound. Thus, for Dalton, water was represented by the symbol ○⊙, denoting the combination of 7 parts of oxygen with 1 of hydrogen.

Berzelius (1815) took the final step by using Latin initials for all the elements, dropping the circles which had surrounded them, and employing affixed numerals to indicate the number of times the symbol had to be repeated. It is true that Berzelius spoiled the uniformity of his system by using a special dot symbol for oxygen and writing such formulæ as $\dddot{S}$ for sulphur trioxide. These dotted symbols, however, found little favour except amongst mineralogists, and gradually passed out of use. The disuse of the circles is not without significance—the symbol to Berzelius represented a combining weight rather than a concrete atom, and the dual quantitative use persists in the interpretation of symbols to-day. The symbol C stands for one atom of carbon or "twelve parts by weight" of carbon. So we may say that more than a hundred years ago a system of formulation had been reached which, with minor alterations, is in use at the present time for the representation of elements and the composition of compounds, and is never likely to be superseded. It is uniform, plain, and simple in itself, and simple to use in the equations representing chemical change.

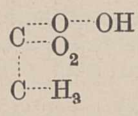
The purely compositional formulæ, however, fall far short of expressing what calls for expression in various classes of chemical compounds: action and structure have to be considered as well as composition. The dualistic formulæ of Berzelius illustrate early attempts in this direction. The formula of sodium sulphate is not written empirically as Na_2SO_4, but dualistically as Na_2O,SO_3. This formula indicates *inter alia* that the sodium and the sulphur belong to two essentially different parts of the compound. The modern electrochemical dualism writes $Na^{\cdot}{}_2SO_4''$, again indicating the same division of a positive from a negative portion. In organic chemistry the representation of structure by means of formulæ achieved success by the clear recognition of valency—in particular, the quadrivalence of the carbon atom. At this point of development the notion of the atom as structural unit becomes indispensable.

The valency of an element on its experimental side is in essence a numerical conception. We divide a weight by a weight, namely, the atomic weight by the equivalent weight, and obtain in consequence a mere number. When we pass from element to atom, however, the conception undergoes a transformation, and receives a concrete meaning. The valency of an atom may be interpreted as its capacity for combining with other atoms, again a numerical conception, but one

[1] Presidential address delivered at the annual general meeting of the Chemical Society on March 22

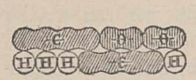
leading directly to a symbolism and indirectly to a mechanical interpretation. Each atom is conceived as having a definite number of places for the attachment of other atoms, and as the number is in each case small we can conveniently represent it in a graphic symbol.

It is not without interest to look back to the origin of graphic or constitutional formulæ and see the beginnings of our conventional system. Couper and Kekulé, the originators of the idea, suggested systems widely differing from each other. Couper (1858) symbolised acetic acid as follows,

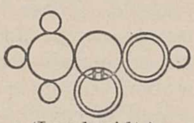


in appearance a near approach to present-day usage if we allow for the fact that he assumes O=8 and C=12. The manner of linking of various atoms is indicated, but their valency is not clearly symbolised. Kekulé's graphic formula (1859) for the same substance is shown below.

Acetic Acid.



(Kekulé.)

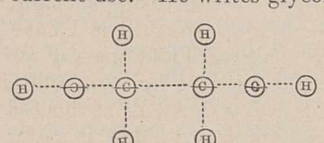


(Loschmidt.)

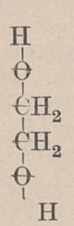
The valency is satisfactorily represented, but the linkage of the atoms is confused. Only atoms touching in a vertical line are supposed to be directly linked. The system is cumbrous, and Kekulé himself used it but sparingly. For branched chains it becomes impracticable.

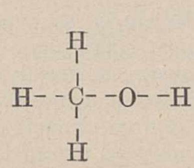
Loschmidt (1861) devised a clear logical system which, although he formulated by its means hundreds of compounds, some of a very complex nature, found no favour amongst chemists. His symbol for acetic acid is given in the figure. Here linkage and valency are adequately represented, but the atomic symbols are arbitrary, and the system, like Kekulé's, is cumbrous to use.

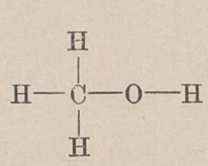
Simultaneously with Loschmidt, Crum Brown (1861), although he was unaware of Couper's work, used a symbolism resembling his, and practically identical with that in current use. He writes glycol as follows:



Here valency and linkage are clear, and the atomic symbols are no longer arbitrary. Wurtz in 1864 gave the following formula (I.) for the same substance:

(I.) 

 (II.)

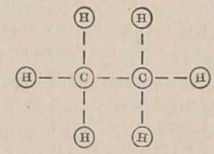
 (III.)

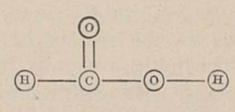
The line of development of modern graphic formulæ, then, is through Couper, Crum Brown, and Wurtz, and not through Kekulé or Loschmidt. The reason for the preference shown by chemists is that the symbolism adopted is more obvious, simpler to use, simpler to reproduce, and easily adaptable to all organic compounds.

There is a dual character in our graphic formulæ which it is important that we should realise. Let us begin with the graphic symbols of the elements, thus:

H–, –O–, –C–, where each short line represents a unit of valency. To the graphic symbols of molecules is but a step; the atoms are represented as united together, the valencies indicating the manner of attachment (II.). The directness or indirectness of union of the atoms is here given; no hydrogen atom is in this formula directly attached to another; they are only indirectly united through carbon or oxygen. For brevity, we join up the lines representing the valencies of the various atoms and obtain the customary formula (III.). A great change in significance has, however, at this stage taken place: the valencies have become "bonds"—the idea of force has entered. What that force is remains indeterminate; it is merely something binding atoms together, and the interpretation of the symbols is not quantitative in this respect. The "bonds" do not represent equal forces; it is patent that the bond between hydrogen and carbon in the formula for methyl alcohol represents a different force from that between hydrogen and oxygen. The current symbolism may then be interpreted in two senses; the lines joining the atomic symbols may be taken to represent on one hand merely the union of the atoms to the symbols of which they are attached, or they may represent forces existing between these atoms. Confusion of these two senses sometimes leads to erroneous reasoning.

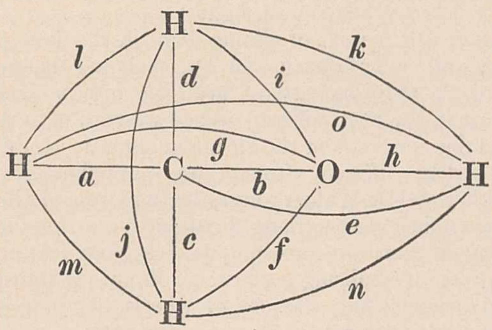
This dual character of graphic formulæ is noticeable from their earliest employment, and I need make no apology in illustrating it from the work of Crum Brown, whose recent death deprived our Society of its senior past-president. In the formula for glycol quoted above he states (1861) that the dotted lines therein employed represent polar forces. In 1864 he represents ethane thus (IV.),

(IV.) 

 (V.)

each valence being written independently. He says: "I may here shortly explain the graphic notation which I employ to express constitutional formulæ. . . . An atom is represented by its usual symbol surrounded by a circle with as many lines proceeding from it as the atom contains equivalents. . . . When equivalents mutually saturate one another the two lines representing the equivalents are made continuations of one another." Here he has discarded the idea of polar force in his original formulation in favour of the simpler conception of number of equivalents. In 1866 he writes continuous lines between the symbols, and in 1868 puts the matter thus: "The structural formula of formic acid [V] indicates first, that the four carbon equivalents form one atom, the four oxygen equivalents two atoms, and the two hydrogen equivalents two atoms; secondly, that these equivalents are united in pairs, thus—*co, co, co, ch, ho*; but it does not in any way indicate (and we do not know) what is the *potential* of each of these pairs—that is, how much energy would be required to separate the equivalents from each other. We know that this potential depends upon the structure, and we can to a certain extent trace the nature of this dependence, but as yet we cannot express the potential numerically, and till we can do that we do not fully know the constitution."

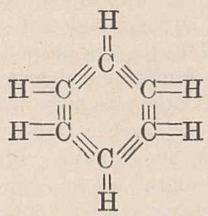
On one hand, then, our "bonds" stand for mere units of valency; on the other, they are an imperfect representation of forces. Were the representation of forces more complete, methyl alcohol would appear somewhat as shown in the figure below, the small letters representing numerical values. Even this formula, however, only gives the magnitude and not the real direction of the forces, and is besides static, not kinetic. We naturally shrink from complexity such as this: imagine the formula of sucrose on a similar basis. We must content ourselves with something simpler, and

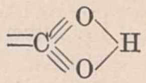


Methyl Alcohol.

yet the simple valency formula has for long been felt to be inadequate. Apart from the idea of definitely directed valencies which leads to stereochemical formulæ, the idea of representing partial valencies has been constantly in the foreground. We cannot properly split valencies in the old sense, but we can subdivide forces *ad libitum*. If the subdivision is carried too far, however, the formulæ may approach in complexity formulæ with quantitatively measured forces, such as that indicated in the figure.

What the chemist requires in his system of formulation is something, not which he can *measure*, but which he can *count*—counters, in short. Such numerical counters he possesses in valencies, in co-ordination numbers. He may be forced to consider the adoption of counters of different kinds, for the purpose of representing essentially different distributions of force; but these counters, if they are to be of general practical value, must neither be too numerous nor of too great variety. Partial valencies, augmented valencies, diminished valencies, virtual valencies, represented by lines of various sorts, thick, thin, curved, dotted, etc., all tend to complicate formulæ, which lose in obviousness what they gain in definition. The humiliating fact must be admitted that the average man does not succeed in counting quickly and accurately by inspection any larger number of "bonds" than he has fingers on one hand, unless they are appropriately grouped—witness the wrong valencies found, not merely in examination scripts, but even on the printed page. We ought, then, to set strict limits to the splitting of "bonds" and the issue of fractional valency counters. Fortunately, the physicist has provided us with a new counter, the electron, which has the great merit of being a physical reality, and, moreover, of being an undecomposable magnitude, so that there is no temptation and no possibility of dividing it further. This counter enables us practically to halve ordinary valencies, and so offers many advantages. In the original form given by J. J. Thomson, lines in the formulæ are made to represent tubes of force passing from an electron of one atom to the positive core of another, and since in electrically neutral atoms, for each tube of force which passes out of an atom a return tube must come in, directly or indirectly, one valency line on the old scheme is represented by two tubes of force on the new. The new formulation enables us to write, for example, symmetrical formulæ for benzene and for the carboxyl group, if we so desire, thus:





Or, again, we may represent the valency electrons directly in our formulæ, each atom being equipped with its doublet, sextet, or octet. Such formulæ, or modifications of them, are coming extensively into use when multiple bonds are in question, and there is no doubt that with the electron or electronic tube of force as counter we obtain a more adaptable and more flexible formulation of organic compounds than that afforded by the older valency formulæ, although only with some sacrifice of their simple character.

It will be gathered from what I have said that my plea is for the utmost obviousness of our symbols and formulæ. Their content and connotation may be as rich as we please; the symbols themselves should be of elementary simplicity. But, it may be asked, why should we seek to limit the investigator striving for chemical self-expression to four whole valencies for carbon if he wants a dozen partial valencies to facilitate his own thought or to convey his exact meaning? And why should he hesitate to adorn his formulæ with arrows or positive and negative signs of polarity if he feels the necessity? The answer to such questions must be of a practical nature. The investigator for his own use may employ a symbolism as elaborate and as complex as he chooses, but if he wishes to secure the understanding and sympathy of others he must curb any spirit of exuberance. A system of chemical formulation to have general currency must not be too elaborate. Otherwise, although it effects economy of thought to the expert who devises it, it may demand such a mental strain of the general chemical reader as to defeat a main purpose for which it was planned, namely, the communication of knowledge. I would quote, both with regard to chemical symbolism and to chemical nomenclature, the words used by a character of Henry James concerning literature, "The observer is nothing without his categories, his types and varieties. . . . That's for his own convenience; he has privately a terminology to meet it. . . . But from the moment it's for the convenience of others, the signs have to be grosser, the shades begin to go. . . . Literature, you see, is for the convenience of others. It requires the most abject concessions." Scientific literature is, above all, for the enlightenment and convenience of others, and scientific specialists must be prepared to make concessions to their weaker or less expert brethren. But whether the symbols we use are simple or complicated, we should always be clear as to their true significance, and be on our guard against their distracting our thoughts from the realities which they partly reveal and partly obscure.

Recent Contributions to Aviation Problems.

By Prof. G. H. BRYAN, F.R.S.

THE attempts which have hitherto been made to explain the continuous sustentation of tropical and other birds without the performance of muscular work have left many doubtful points requiring to be cleared up. Observers have frequently sought to attribute the phenomena to something acting in violation of the principles of elementary mechanics, and have succeeded in establishing this peculiarity, not perhaps in the way that they intended, but by the chaotic way in which such terms as force, momentum, weight, energy, lift, pull, drag, and gravity are confused by them, and occur indiscriminately mixed up in their writings. In a paper on "Meteorology and the Non-Flapping Flight of Tropical Birds," published in the Proceedings of the Cambridge Philosophical Society, xxi. 4, Dr. Gilbert T. Walker has now sought to bring sound scientific principles to bear on the numerous observations in India published by Dr. Hankin. From observations of the temperature of the air at Agra at different altitudes and hours of the day, Dr. Walker finds conditions of instability leading to the formation of strong ascending air-currents, and observations in Egypt and various parts of India indicate conditions of "bumpiness" in the atmosphere caused by ascending currents, covering the periods employed by birds for "soaring."

Dr. Walker finds that the angle of gliding of the most efficient recent aeroplanes is sufficiently low to satisfy the conditions necessary for continuous sustentation in the presence of these currents, and he examines in detail three possible sources of internal work in the atmosphere, namely, ascending currents, variations of horizontal velocity as functions of time and place co-ordinates, and Lord Rayleigh's hypothesis of variation of horizontal wind velocity as a function of the vertical altitude co-ordinate. He also carefully considers the structure of the birds' wings, in comparison with those of the Handley-Page machine, and the effect of the flexibility of the quills on the aerofoil form in ascending and descending glides. Both from theory and from actual observation, it is found that the ascending air-currents in the higher regions of the atmosphere are greater in diameter than lower down, and from actual observation he contradicts Dr. Hankin's statements according to which birds are seen rising in descending currents. It would thus appear from Dr. Walker's observations that, in the region dealt with by Dr. Hankin, the atmosphere possesses sufficient internal energy to satisfy the conditions of "soarability" required by the latter observer. In regard to the violation of mechanical principles, both hypothetically by birds and actually by writers, we cannot do better than quote Dr. Walker's remark that . . . "it is strangely" (asterisk and footnote with references follow) "necessary to insist that it is as impossible to derive energy from a wind that is constant in time and space as it is from a perfect calm." To theories based on a denial of this principle the late Sir Hiram Maxim used to point out the enormous velocity of the wind due to the earth's rotation and its orbital motion about the sun, and he suggested that if writers believed in these theories, why did not they utilise this energy for the purposes of flight?

The recent records of gliding flight in the daily press afford ample confirmation of Dr. Walker's theories in regard to the quantity of *available* internal energy present in the atmosphere. When we read of aviators remaining for hours in the air under climatic conditions not widely different from those prevailing in Dr. Hankin's and Dr. Walker's investigations, and of 7 horse-power engines making long flights at a cost for fuel of not more than a penny a mile, we have reasonable prospects of realising a system of cheap transport largely superseding the use of wheels bumping over stony roads or iron bars placed end to end.

Apart, however, from the precariousness of the distribution of the necessary internal energy in space and time, a motorless aeroplane is in constant danger of being suddenly brought to rest relative to the air, or, more accurately, losing all headway, at which instant it has a vertical acceleration due to gravity, and the resistance to rotation (pitching, yawing, rolling) becomes technically describable as "a small quantity of the second order," thus approximating to the conditions assumed in the problem of rigid body rotation under no forces.

We are constantly reading of accidents which seem to suggest that they have arisen from this condition of affairs, even in the case of motor-driven machines which are at least equipped with a more adequate means of extricating themselves from this eventuality.

No system of aviation will ever be satisfactory, however, until backed up by a more thorough solution than we now have of the equations of motion of the "perfect aeroplane." Perfect fluids, perfect conductors and dielectrics, perfectly smooth bodies, perfect gases, and so on, are very familiar terms, but the "perfect aeroplane" has not yet figured in literature as such, though various formal representations have been proposed for it from the time of Lanchester's phugoid system down to the systems of Brodetsky and the present writer. These last systems reduce the study of the perfect aeroplane to the solution of a system of assumed and stated equations, in fact a problem in pure mathematics only.

If the conditions necessary for steady motion (under forces in equilibrium) and inherent stability are satisfied, an aeroplane will tend to assume a state of steady motion provided that the initial conditions represent a sufficiently small displacement from the steady state. But under widely different initial conditions it may tend to assume an altogether different motion, and, for example, it may sooner or later lose headway or crash to the ground, pitching over and over. We are thus led to considerations of *superstability*, an inherently *superstable* aeroplane being defined as one which, like a non-capsizing lifeboat, will tend to assume a state of steady motion whatever be the initial conditions of projection; failing that, to investigate the limits of superstability; in other words, the limiting initial conditions under which the machine tends towards instead of away from steady motion. It is clear that such an investigation will involve the search for periodic solutions of the equations of motion which, though difficult, should not be harder than many problems on which pure mathematicians have set their faces. In condition with lateral displacements a spiral gliding motion would represent one limit of superstability, but there are probably others which may or may not occur in practical applications. At present Dr. Brodetsky appears to be the only applied mathematician who has really made substantial advances tending in this direction.

It seems rather probable that further developments will involve the solution of integral equations.

Possible future applications to the location of aircraft are suggested by a paper by Dr. A. B. Wood and Capt. H. E. Brown on "A Radio-acoustic Method of locating Positions at Sea," read before the Physical Society on March 9, and the discussion thereon, in which Capt. Fowler, Major Tucker, and others took part. In this method a wireless signal is made at the same instant that a charge is fired into the sea, and the times of arrival of both signals are recorded at land stations, thus determining the distance of the ships from them. The method is obviously applicable to the sound ranging of aircraft in commercial aviation, but, as Mr. Smith remarked in the discussion, the captain of a vessel would certainly need to make the observations himself, and, up to the present, experiments on detection of acoustic signals, and especially echoes of sound signals, by means of apparatus carried on aircraft, have not been so successful as could have been wished. It is to be hoped, however, that experimental work on this subject will be continued, as the means hitherto at our disposal for location of aircraft leave much to be desired, especially if cross-country flights are to be effected at any considerable distances from the main air routes.

The possibilities of employing helium in airships are discussed by Capt. G. Arthur Crocco in the *Atti dei Lincei*, xxxii. (1) 2, 3. It is estimated that from the natural gas wells in the United States a supply of three million cubic metres per annum is obtainable, and taking twenty years as the life of a well, the cost works out at two dollars per cubic metre. This supply would not be sufficient to replenish the consumption of more than one airship in active continuous service on long-distance traffic under existing conditions, and Crocco considers in detail the different causes of loss and the means of reducing them within practicable limits. The author separates the consumption of gas into three categories, which he describes as "consumption of navigation," "osmotic diffusion," and "washing of the gas" necessitated by loss of purity, and due to endosmotic entry of air into the envelope accompanying the exosmotic diffusion of the helium. The annual losses of gas due to these three causes are in the ratio of 100, 10, 1, and it is estimated that if the first could be eliminated the annual loss of gas by an airship could be reduced to 20 per cent. of the total volume, and that a large fleet of commercial airships could be maintained in continuous working at a reasonable cost.

The "consumption of navigation" represents the amount of gas let out to compensate for the loss of weight of the fuel, and, as pointed out, this assumes serious dimensions in long-distance journeys where excessive buoyancy cannot be overcome by lowering the elevators. The necessity for this discharge of gas can be obviated in two ways, namely, by condensing the water in the products of combustion and by "thermic sustentation," and in his second paper Crocco examines the former method. It is estimated that 1000 grams of fuel contain 150 grams of hydrogen, which, combining with the oxygen of the air, give 1350 grams of water, so that by condensing this the gain of oxygen can be made to compensate for losses in other directions. The necessary superpressure to effect this condensation can be secured by means either of causing a back pressure in the motor or by separate compression. The paper contains formulæ and calculations of the amount of the superpressure required to effect the necessary condensation, and this of course is a function of the degree of saturation of the atmosphere. It is found that this only reaches a serious amount in the case of very hot and dry weather, such as in average climates only occurs on a few days in the year. Remembering that only 1000 grams out of 1350 have to be condensed, the author finds that the loss of power required for the purpose is not sufficient to interfere with the practical application of the method when the effects occurring exceptionally are reduced to annual percentages.

In a paper communicated through Prof. Levi Civita to the *Atti dei Lincei*, xxxi. (2) 1-2, Dr. E. Pistolesi employs moving axes to formulate the differential equations of motion of a fluid in the field of velocity produced by a screw propeller. In this way the problem is reduced to one of steady motion. The method is closely similar to one adopted many years ago in connexion with problems on the small oscillations of gravitating rotating fluids, with the difference that in applications of approximate methods the velocity components relative to the airscrew will not be small, but in certain cases it may be possible to regard as small the components relative to fixed axes set up by the motion of the screw.

Another hydrodynamical line of investigation which has recently come into prominence in connexion with the effects of skin friction on the resistances of aircraft is the theory of viscosity. This forms the subject of two papers in the *Atti dei Lincei*, xxxii. (1) 1, 2, by Dr. Umberto Cisotti, also communicated by Prof. Levi Civita, the first dealing with motion in canals and the second with damped waves.

The object of the present article has been to direct attention to papers published elsewhere than in the technical journals and periodicals, such as those of the Royal Aeronautical Society, the Aeronautical Research Committee, or the Institution of Aeronautical Engineers, all of which are replete with results of other important and valuable investigations.

Obituary.

Canon W. W. Fowler.

Canon William Weekes Fowler, Vicar of Earley, Reading, died on Sunday, June 3, at seventy-four years of age. He was suddenly taken ill in the vestry before the service, and died soon after service began. Having always been a man of untiring energy, we feel sure that he would have preferred to die in harness rather than to have endured any long illness.

Canon Fowler was the son of the Rev. Hugh Fowler, Vicar of Barnwood, Glos, and was born in January 1849. He was educated at Rugby, where he gained a scholarship for Jesus College, Oxford. He took a first in Classical Moderations, and a third in Lit. Hum.; he was ordained, and became a house master at Repton in 1873. In 1880 he was elected head-master of Lincoln School, where he remained for more than twenty years. Bishop King appointed him Canon of Welton Brinkhall in Lincoln Cathedral. He was Rector of Rotherfield Peppard, Oxon, in 1901–1904. In 1905 he became Vicar of Earley, in the gift of the Vicar of Sonning. In 1907 he was president of the Head-masters' Association, and for many years was an energetic member of the Reading Guardians.

Canon Fowler was best known in scientific circles as an entomologist, being a sub-editor of the *Entomologists' Monthly Magazine* from 1885 until the day of his death. He was secretary of the Entomological Society of London in 1886–1896, president in 1901 and 1902, and vice-president in 1903. He was a member of the Science Committee of the Royal Horticultural Society, and in 1906–1907 was a vice-president of the Linnean Society.

Besides writing numerous notes and articles on Coleoptera, Heteroptera, etc., in the scientific magazines, Canon Fowler's chief works were the volumes on Coleoptera for the "Fauna of British India," including the General Introduction, the Cicindelidæ and Paussidæ, published in 1912; the volumes on Hemiptera-Homoptera, with W. L. Distant, in the "Biologia Centrali-Americana," published in 1887–1909; a "Catalogue of British Coleoptera," with Dr. Sharp in 1893, and with Rev. A. Matthews in 1883; the "Coleoptera of the British Isles" in five volumes, published in 1887–1891, and a sixth supplementary volume, with Mr. H. St. J. K. Donisthorpe, published in 1913. He also published a number of text-books on the classics, etc., for use in schools.

Canon Fowler was a very broad-minded man, generous and unselfish, and was much beloved by all who knew him. He was always ready to help younger men with advice and entomological specimens, etc., and his death leaves a blank in the ranks of the older entomologists which will not easily be filled.

Horace Donisthorpe.

Dr. Hans Goldschmidt.

The inventor of the Goldschmidt thermite process, Dr. Hans Goldschmidt, died after a short illness on May 21, in Baden-Baden.

Hans Goldschmidt was born on January 18, 1861, in Berlin, where his father, in 1847, founded the chemical works of Th. Goldschmidt, of which he was the director until his death in 1873. Hans Goldschmidt studied chemistry at Leipzig, Berlin, Strasbourg and Heidelberg, where he graduated in 1886 under Robert Bunsen. After this he continued his studies in electro-chemistry and travelled in foreign countries; this widened his views on economic questions. In the year 1888 he entered, as a partner, the works of his father, in which his brother, Karl Goldschmidt, had taken the lead since 1882.

Goldschmidt's first technical achievement was the invention of an electro-chemical process for recovering the tin from white iron waste, which has found wide application in many countries. His name became famous in the year 1894, when he succeeded in reducing oxides by combustion with powdered aluminium, and by the tremendous heat of this reaction, metals of a high melting-point, such as chromium, vanadium, molybdenum, tungsten, and their alloys with iron and other metals, melt and can be produced in a pure state. As a by-product, corundum is formed, which can be technically utilised for grinding purposes. The thermite process found an even larger application by the use of mixtures of aluminium metal with iron oxide for welding together the ends of rails of tramways and for repairing broken machinery, especially of ships. Hans Goldschmidt also discovered a process for avoiding the formation of holes in iron castings and for improving steel castings by the addition of aluminium.

Hans Goldschmidt was one of the founders of the Bunsen Society for Applied Physical Chemistry, and was for many years its president. He was awarded the Elliot-Cresson-medal of the Franklin Institute. His high scientific standing and good nature will ensure for him a place in the history of technical chemistry and in the memories of his numerous friends both in and out of Germany.

We regret to announce the following deaths:

Prof. Heinrich Boruttau, a director of the Friedrichshain Hospital, Berlin, whose work was especially concerned with the relations of physics to medicine. He also worked on physiological chemistry and problems of nutrition. He died on May 15, aged fifty-four.

Dr. W. d'E. Emery, formerly director of laboratories and lecturer on pathology and bacteriology to King's College Hospital, on June 19.

Mr. E. J. Steegmann, for many years secretary to the Royal Commission on Human and Bovine Tuberculosis, on June 8, aged fifty-five.

Current Topics and Events.

THE approaching twenty-fifth anniversary of Sir Ronald Ross's epoch-making discovery of the mosquito transmission of malaria is made the subject of a powerful letter in the *Times* advocating the establishment of a Ross Institute in London, to be called the Ross Clinique for Tropical Diseases. The letter is signed by the Marquess of Lansdowne and Lord Hardinge, ex-Viceroys of India, by a number of business men connected with the Tropics, and by presidents and directors of scientific societies at home and abroad. Among the latter are included the directors of the Pasteur Institutes of Paris and Brussels, of the Gorgas Institute in Panama, and of the School of Hygiene, Johns Hopkins University, the president of the International Health Commission of the Danube, and the Director-General of the United States Public Health Service. The object of founding a Ross Institute is twofold. On one hand, it is in honour of an Englishman to whom the whole civilised world and the British Empire in particular owe a debt of gratitude, and it is intended to be a public recognition of his services while he is still among us, and a lasting memorial to him after his death. On the other hand, it is to enable Ross, a man of genius, assisted by other experts in medical science, to exercise his special gifts in the initiation and continuation of researches into the still unsolved problems of tropical medicine and hygiene. It is to be clearly understood that the Ross Clinique is intended to supplement and not compete with the existing schools of tropical medicine. Its aim is research alone, for which there is plenty of room in the great capital of the British Empire.

IN its issue for June 19 the *Times* reported the great outbreak of lava on the north-eastern flank of Etna, which occurred on the early morning of Saturday, June 16, and was already causing widespread devastation. Further details, with a map, have appeared in later issues of the *Times*, together with a report by Prof. Ponte, who has ascended the slope as far as possible. As in so many previously recorded eruptions on the slopes of Etna, the lava has broken out from several mouths arranged along a fissure, which in this case is near the crater of 1879. At the time at which this note is written, it is early to speculate as to the extent to which the flow may spread, and the experiences of Catania on the southern side, often repeated in historic times, indicate the magnitude and the vitality of the great reservoir that has played so important a part in the physiography of Pleistocene times. Charles Lyell, from 1830 onwards, roused an interest in Etna as one of the most appealing examples of earth-structures reared by forces now in action. A detailed map, on which dates are inserted, such as that published by O. Silvestri in his "Viaggio all' Etna" in 1879, shows how, layer by layer, the vast composite mass continues to be built up and maintained. The neighbourhood has now been evacuated, and the scenes of flight depicted in d'Annunzio's amazing film "Cabiria" are repeated in the tragedy of to-day. Activity is also reported in the small cones that are growing within the crater of explosion formed in Vesuvius in 1906.

THE memorial portrait of Alfred Russel Wallace was unveiled at the Natural History Museum and presented to the Trustees on June 23. Wallace was born in 1823 and died in 1913, so that the presentation has appropriately taken place in the centenary year of his birth. Shortly after his death a committee was formed to collect funds for the memorial, which was to take two forms, a tablet in Westminster Abbey and a portrait in the Natural History Museum. The first was completed and placed in position in 1914, but the latter was deferred owing to the War and was only recently finished. Sir James Marchant, in offering the portrait to the Trustees, gave a short account of the formation of the memorial committee, and concluded by asking Sir Charles S. Sherrington, President of the Royal Society, to unveil it. In his address the latter alluded to the fact that much of the fruit of Wallace's expedition in the Malay Archipelago is incorporated in the Museum collections, and dwelt upon the happy circumstance of the juxtaposition of Wallace's portrait and of Darwin's statue, two men whose discoveries at the same moment and on the same theme were placed before the scientific world. Prof. E. B. Poulton, a co-worker of Wallace, spoke of his life and work, and testified to the generosity of his character and to the unselfish enthusiasm with which he encouraged and assisted the work of others. The portrait was accepted on behalf of the Trustees by the Archbishop of Canterbury, who undertook that it should receive the care that the Museum accorded to its treasures. He remarked upon the interest which students felt at seeing what manner of men they were who had made such great advances in natural science. The portrait, which is an extremely good likeness, was painted by Mr. J. W. Beaufort from photographs.

A WRITER under the most appropriate pen-name of Æolus has recently contributed to the *Wimbledon Borough News* two lengthy letters of protest against the by-pass road that is planned to run alongside the ground recently added to Wimbledon Common on the further side of Beverley Brook. While we sympathise with his love of a Nature unspoiled by the dust, noise, and smell of motor cars, we cannot forget that this road is only part of a scheme settled years before the War, and already modified in this area to meet the views of those who obtained the extension of the Common. A further scheme, already mooted by the John Evelyn Club for Wimbledon, which might well receive support, is to fence off part of this tract as a Nature reservation. Wimbledon is singularly rich in birds, and it is even possible that some of our wild mammals may yet linger in the district. If the Common Conservators could see their way to provide a sanctuary for them they would earn the thanks of all lovers of Nature.

CAPTAIN R. AMUNDSEN has abandoned his projected flight from Alaska across the Pole to Spitsbergen. The *Times* reports that an official communication to this effect has been issued by the Admiral commanding the Norwegian fleet. The statement is made that a trial flight on May 11 proved very unsatisfactory. In full expectation of the flight being attempted in the third week in June, the Norwegian Government had sent the *Farm* to Spitsbergen with supplies, and the transport *Flint*, carrying three seaplanes, arrived at King's Bay in the middle of June. The seaplanes were to patrol the edge of the polar pack to the north and north-west of Spitsbergen in order to render assistance to Captain Amundsen and his pilot, Lieut. O. Omdal, in the case of any enforced descent. It was proposed, if the distribution of the pack rendered it advisable, to deposit supplies of petrol and food on the ice, each marked with a conspicuous beacon.

"NATIONAL Baby Week," which is to be observed on July 1-7 under the auspices of the National Baby Week Council, 117 Piccadilly, W.1, brings into prominence the many problems of infant mortality. These problems have two phases which seem dependent upon biological conditions: (1) the comparatively high death-rate in the first month of life, and (2) the comparatively high death-rate of male infants as compared with female infants. In the year 1921, the most recent for which detailed figures are available, there were 1051 male births for every 1000 female births, while the deaths of male infants occurred at the rate of 92·85 per 1000 births and female infants at 72·16 per 1000. During the first four weeks of life, the "neo-natal" period, the death-rate was 40·01 for males and 30·27 for females per 1000 births. These ratios stand with little variation year by year, though during and after the War the ratio of male to female births—as was expected on an empirical basis from historical records alone—was slightly higher than the normal (104 males to 100 females). It would seem that this greater susceptibility to the strains of environment is characteristic of the male sex. The neo-natal death-rate, which has yielded but little to those influences which have proved so effectual in lowering the infant mortality rate as a whole (from 154 per 1000 births in 1900 to 77 in 1922), constitutes another difficult problem in public health. An interesting recent investigation (by post-mortems) into the causes of death in sixty-two cases of neo-natal mortality showed that while 73 per cent. were due to conceivably preventable conditions, the remaining 27 per cent. were due to malformations—a finding which might seem to indicate that neo-natal mortality may be but the expression in human life of Nature's trial and error—a biological interpretation which would, however, tend to discourage infant welfare discussions on this subject in the forthcoming "National Baby Week."

IN the current number of the *Poetry Review*, Mr. Oliver C. de C. Ellis has a lively and cheering article attacking the fallacy that there is any opposition between poetry and science. He might very well have gone further than he has. It would be truer to say that the highest gifts in poetry are closely akin to, or even identical with, those required for the highest achievements in science. Some of the greatest poets, Dante, for example, have been masters of the science of their time, and Wordsworth, in a famous passage in the preface to his second edition of the "Lyrical Ballads," looks forward to a time when modern science, having entered into the mental equipment of all cultivated men, will inspire a new order of poetry, as philosophy and rural lore inspired Lucretius and Virgil and medieval science inspired Dante. Both orders of mental effort depend, as Mr. Ellis says, upon the imagination, but whereas the man of science imagines laws and relations of things which may be verified and used for guidance as to their own future action, the poet sees them in their relation to the human soul. In this sense the work of the man of science is objective and stands on the order of events; the work of the poet is subjective or moral, and depends for its appreciation upon a state of mind attuned to his own. "Poetry," as Wordsworth tells us, "is the wealth and fine spirit of all knowledge"; "it is the impassioned expression which is in the countenance of all science." And, one must add, that whereas science aims at pure truth, poetry, having this emotional content, aims also at giving pleasure. It implies a certain form and a certain emotional effect, though the substance must also be truth. It is the "first and last of all knowledge."

THE British Mycological Society is organising a phytopathological excursion to Wye, in Kent, on Saturday, July 7. Those intending to take part in the excursion should communicate with Capt. J. Ramsbottom, at the British Museum (Natural History), South Kensington, S.W.7, by Wednesday, July 4.

ACCORDING to the *Chemiker Zeitung* for June, Dr. Paul Knoller, lecturer and assistant at the University of Freiburg (Switzerland), has been appointed professor of mineralogy and petrography at Dayton University, Ohio.

OWING to the increase in the work of the Rothamsted Experimental Station, it has been decided to appoint an assistant director, and Dr. B. A. Keen, head of the Physics Department, has been selected for this position.

A CIRCULAR tablet of blue glazed ware bearing the inscription "James Clerk Maxwell (1831–1879), Physicist, lived here," has been affixed to 16 Palace Gardens Terrace, Kensington, where Clerk Maxwell resided for a time, by the London County Council. Maxwell's occupation of the house probably dated from the latter part of 1860, immediately after his appointment to King's College, or the early part of 1861. The first reference to it in his biography by Campbell and Garnett is in a letter dated May 21, 1861. He resigned his appointment as from Easter, 1865, and left the house for good in March 1866 (*ibid.* p. 260).

AT a meeting of the Royal Society of New South Wales on May 2, the following officers for 1923–24 were elected:—*President*: Mr. R. H. Cambage. *Vice-Presidents*: Prof. C. E. Fawsitt, Mr. J. Nangle, Mr. E. C. Andrews, and Mr. C. A. Sussmilch. *Hon. Treasurer*: Prof. H. G. Chapman. *Hon. Secretaries*: Prof. O. U. Vonwiller and Mr. G. A. Waterhouse. *Members of Council*: Dr. C. Anderson, Sir Edgeworth David, Mr. W. S. Dun, Dr. R. Greig-Smith, Mr. Charles Hedley, Rev. E. F. Pigot, Mr. W. Poole, Mr. H. G. Smith, Prof. J. Douglas Stewart, and Prof. R. D. Watt.

THE David Livingstone Centenary Medal for 1923 has been awarded to Dr. T. Griffith Taylor, associate professor of geography in the University of Sydney, Australia. This medal, founded by the Hispanic Society of America and awarded by the American Geographical Society, is given "for scientific achievement in the field of geography of the southern hemisphere." Dr. Taylor has made notable contributions to Australian geography, applying the results of his physiographic and climatic studies to problems of settlement and human adaptation. He is the author of several works on Australia and of numerous communications appearing in Australian Government bulletins, and was senior geologist and leader of the western parties on the British Antarctic Expedition of 1910–1913 (Scott's last expedition), on which he has written "With Scott: The Silver Lining" (1915). It is anticipated that the medal will be presented on the occasion of the Second Pan-Pacific Science Congress, which meets in August and September in Australia.

ON June 10 two departments were opened for the public and visitors in the new premises of the Geological Museum of the Petrograd Academy of Science. One of the departments is devoted to the general osteological collection and contains among its exhibits remains of Indricotherium, a giant primitive rhinoceros-like mammal, from the Turgai Oligocene deposits (Indricotherium beds), north of the Aral Sea, recently described by Prof. A. Borissiak (Mém. Acad. Petrograd (viii.) xxxv. N6). The other department, the so-called North-Dvina gallery, is devoted exclusively to the Upper Permian fauna, discovered by Prof. Amalitzky, and contains his types, some of them partly re-developed and re-described by the present curator of the gallery, Prof. P. Sushkin (*Comptes rendus* of the Petrograd Academy for 1921 and 1922).

ONE of the main functions of the Fuel Research Board is a survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, supplemented where desirable by large-scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. It is considered that the best way to carry out this work is by means of local committees, the personnel of which would include colliery owners, managers, representatives of the Fuel Research Board and of the Geological Survey of Great Britain, as well as of outside scientific interests. In this way local knowledge and experience is made available. The first of these committees has now been actively at work in the Lancashire and Cheshire area for nearly eighteen months, and the Board has recently decided to deal with the South Yorkshire area. The South Yorkshire Coal Trade Association and the Midland Institute of Mining, Civil, and Mechanical Engineers are co-operating in the work. The following committee has been appointed: Dr. C. H. Lander (chairman, *pro tem.*), Mr. J. Brass, Mr. Robert Clive (hon. secretary), Mr. H. Danby, Lieut.-Col. H. Rhodes, Prof. R. V. Wheeler, and Dr. Walcot Gibson.

THE annual general meeting of the Research Defence Society, on June 20, when Lord Knutsford presided, was well attended, and the necessary business was quickly done. Dr. Saleeby lectured on "Sunlight and Disease"; and showed lantern-pictures and films illustrating the past and present use of "the sun-cure": especially the amazing results which Rollier has obtained at Leysin; the downright cure, by light alone, of many fearful cases of tuberculosis. If the photographs and the films had not been there, the whole thing would have been incredible. The sun, that careful doctor, had faithfully recorded the work which he had achieved. Dr. Saleeby also spoke of the experimental research which is being pursued into the action of light on life: the relation of light to the storage of phosphorus, calcium, and vitamin A in the body, and so on: but we are still a long way from understanding these mysteries. In Great Britain, a measure of success has been gained at Sir William Treloar's Hospitals at Alton and Hayling Island, and at Queen Mary's Hospital, Carshalton. But what is the good of talking of "sun-cure" in this country, in this weather? It was a sunless day, near the end of a sunless May and June. Besides, in our great industrial cities we poison the air with smoke. Dr. Saleeby's pictures of Manchester and Sheffield were Ruskin's prophecies come true. Prof. Dreyer is working for a better tuberculin-treatment. Mr. Justice McCardie has spoken his mind on the contagiosity of a dusty house in which a consumptive patient had lived. People are learning more about tuberculosis. But, until we get finer summers, use smokeless coal, and abolish slums and overcrowding, we must not expect to repeat the wonders of Leysin in Great Britain.

ON April 6 Mr. G. R. Clarke, the Director-General of Posts and Telegraphs for India, read a paper to the Royal Society of Arts on postal and telegraph work in India. He pointed out that the present problem is not the erection of more wires to carry the increased traffic, but to increase the capacity of the existing wires by the use of multiplex high-speed instruments. Automatic telephone exchanges have proved a great success at Simla and Lahore, and many similar installations are in course of erection. Radio communication has not proved successful in India owing to the "atmospherics" making signalling impossible at certain seasons.

The research department, however, has perfected methods of eliminating the disturbances due to this cause, and so it is hoped that the radio method will be much more widely adopted in the future. During the last year postal and telegraph communication has been established with Tibet and Afghanistan. The Dalai Lama has given every encouragement to the establishment of communication between Lhasa and India. Afghanistan has not yet joined the Universal Postal Union; letters are stamped to India, and a charge is made on delivery, but the amount of this charge seems to be uncertain. In the discussion on the paper Colonel Edwards said that India offered the most wonderful possibilities in the way of air mail transport. For example, the journey from Calcutta to Rangoon took at present 3-6 days. If an air mail service were employed the time taken would be only 9 hours. Many similar cases could be cited. In England difficulties are caused by fog, but in India the only fogs are the few that occur during the monsoon.

WE have received from the Department of Agriculture and Technical Instruction for Ireland a copy of the catalogue of maps, memoirs, and sections published by the Geological Survey of Ireland. The list includes maps, etc., for the whole of Ireland: they are now to be obtained from the Ordnance Survey Office, Dublin. The one-inch map for the whole country is available in 205 sheets. Of the 16 sheets of the quarter-inch map only four appear to be published. There is a recent six-inch map of Dublin and surroundings. These maps are colour printed.

Our Astronomical Column.

VARIATIONS IN THE SPECTRUM OF θ^2 ORIONIS.—M. F. Henroteau directs attention (*Comptes rendus*, April 30, p. 1210) to the spectrum of the star θ^2 Orionis, which is of magnitude 5·17 and situated in the nebula of Orion (R.A. $5^h\ 30^m{\cdot}5$, Dec. $-5°\ 29'$, 1900), being of the B-type spectrum. In 1904 Prof. E. B. Frost discovered the star to be a spectroscopic double with a radial velocity of 140 km. In 1919 and 1920 M. Henroteau found that in addition to the broad absorption lines of hydrogen and other elements, there were super-imposed on them thin bright lines which gave a velocity less than that accorded by Frost. To verify this, Otto Struve of the Yerkes Observatory obtained several spectrograms in 1922, but these showed no evidence of bright lines. However, another spectrogram on March 2 of the present year displays these sharp bright lines. Thus we have a B-type star, not known as a variable, which intermittently presents bright lines, a phenomenon very rare in occurrence. What adds great interest to this particular star is that it is situated in the nebulosity of Orion, and this situation may account for the peculiarity. M. Henroteau proposes to make a special study of its spectrum.

COLOURS AND SPECTRA OF DOUBLE STARS.—Till recently the course of a star's evolution was considered to be defined by the sequence represented by types O B A F G K M, and the fact that the fainter components of binaries are often bluer than the brighter components was a source of much perplexity. One of the results of the "Giant and Dwarf" hypothesis was to afford a simple explanation of the observed facts, since among giants the blue stage is later than the red; and, conversely, the observed phenomena afford another strong argument for that hypothesis. Mr. Peter Doig has traced the bearing of these facts in two papers during the past year; now Mr. F. C. Leonard returns to it in Lick Obs. Bull. No. 343. He has photographed the spectra of a number of close pairs with a one-prism spectrograph on the 36-inch refractor, finding it possible to get separate spectra even with pairs only 1″ apart; where the magnitudes differed the brighter star was occulted by a screen for part of the exposure. In order to classify the spectra he also took spectrograms of several typical stars with the same instrument, since he notes that slit spectrograms differ systematically from the objective-prism series used at Harvard.

The resulting spectral differences of the components of the binaries were then correlated with absolute magnitudes, and with differences of magnitude and mass, the facts being displayed in a series of diagrams; he classifies stars not fainter than 1.0 mag. (absolute) as giants, the remainder as dwarfs; it is clearly shown that among giants the primary is redder, among dwarfs bluer. Once this law has been established it enables us to make estimates of the absolute magnitudes of stars of undetermined parallax. Further, the difference of spectral type increases as a rule with increasing difference of absolute magnitude or of mass, and there is hope that, by tabulating these differences in as many cases as possible, a clue will be obtained as to the relative duration of the stages of development corresponding to the various spectral types; such information would be of much use in cosmogony. The research also affords a proof that the less massive stars pass through their stages more rapidly than the massive ones; this was indeed generally assumed, but it has been questioned.

The cases of Sirius and o^2 Eridani are noted as anomalous, the discordance in magnitude being much greater than we should expect from the disparity in mass; Mr. Leonard suggests that in the latter case the mass-ratio should be reinvestigated; that of Sirius cannot be much in error.

THE RADIAL VELOCITIES OF 1013 STARS.—Messrs. W. S. Adams and A. H. Jay contribute to the April number (vol. 57, No. 3) of the *Astrophysical Journal* a catalogue of radial velocities which includes many of the results obtained in this line of work at the Mount Wilson Observatory during the past few years. The list is composed almost wholly of stars with spectra of types F, G, K, and M which have been observed not only for radial velocity but also for determinations of absolute magnitude and spectroscopic parallax. The spectrograms have been obtained at the Cassegrain focus of the 60-inch and the 100-inch reflectors, and the latter instrument was employed chiefly for stars fainter than the eighth visual magnitude. Single prism spectrographs with prisms of 64° angle and cameras of 18-inch focal length were used. The faintest star photographed was of magnitude 9·9, and 10 to 15 stellar lines have been measured on each spectrogram, and a list of those most commonly employed is given in the paper. The results here collected have already been used to some extent by Strömberg, Seares, and the authors in investigations of space velocities and the relationship of velocity to absolute magnitude and mass, but their publication makes them now available to all.

Research Items.

FUNCTION OF THE SPLEEN.—More than ten years ago Richet showed that dogs from which the spleen had been removed had to eat more than normal animals to keep their weight constant. In the *Comptes rendus* of the Paris Academy of Sciences of April 16 he states that spleenless animals when starved lose weight more quickly than the controls, and concludes that the organ diminishes denutrition; its normal function, useful but not necessary to the economy, being to slow down metabolism. These observations may possibly be correlated with those of Korenchevsky (*Journ. Path. Bact.* vol. xxvi., 1923, p. 387), who describes hypertrophy and hyperplasia of the germ centres in the spleen in pigeons with beri-beri caused by an inadequate diet of polished rice—perhaps an attempt to compensate for the severe failure of nutrition.

PALÆOCENE PRIMATES OF THE UNITED STATES.—More than ten years ago a considerable collection was made in the Sweet Grass County, Montana, of fossils from the Fort Union Palæocene. The intervening time has been devoted to the cleaning and preparation of these, among which the mammalian remains appear to represent at least forty species belonging to not less than fifteen families and six or seven orders. The descriptions of these will be undertaken, order by order, and ultimately combined into a single monograph. The Primates form the subject of a memoir by J. W. Gidley (Proc. U.S. Nat. Mus., vol. lxiii. art. 1). Until now true Primates have not been reported in America from beds older than the Eocene, and these indicated that earlier forms must have existed, so that it is not surprising, although of the greatest interest, that they do occur in the Fort Union Palæocene, and that all thence are in general of a more primitive type. These early Primates belong to two families: Tarsiidæ, represented by four genera, of which three—Paromomys, Palæchthon, and Elphidotarsius—are new; and Plesiadapidæ, with one new genus—Pronothodectes. No representative of the Notharctidæ appears in the Fort Union collection. The author discusses the affinities and relationships of these various forms. He concludes that the early tarsiids as at present understood do not represent a natural group. It would seem, however, that within this group are to be found the ancestral stock which gave rise to the living Tarsiers; and possibly also the ancestral form whence ultimately sprang the aberrant lemur—Daubentonia—of Madagascar. The root group, or beginning of the Primates as a distinct order, has still to be sought in yet older formations.

EOCENE PELECYPODA OF BURMA.—The fauna of the Eocene of Burma is especially rich in Gastropoda, but contains a lesser proportion of Pelecypoda. The former were placed in the hands of the late Mr. Vredenburg for description, while Dr. G. de P. Cotter has dealt with the latter (*Pal. Ind.*, New Series, vol. vii., mem. 2). Twenty-five species are described and figured, of which nearly all are considered to be new. They indicate that the Yaw stage, to which the bulk belong, is to be correlated with the Upper Eocene of Java and the Bartonian of Borneo. The accompanying plates are remarkably good.

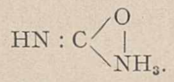
SOIL BACTERIA AND ORGANIC ANTISEPTICS.—In an article in *Discovery* for June, Mr. P. H. Gray discusses the utilisation of organic antiseptics by bacteria of the soil. Phenol, cresol, toluene, and naphthalene applied to the soil disappear. This disappearance is due to the existence of bacteria in the soil which attack and destroy these compounds. Some 200 strains of antiseptic-decomposing bacteria have been obtained from over a wide area in Great Britain; they are able to grow in solutions containing the antiseptics and even to utilise these compounds as a source of energy. It is possible to increase the fertility of the soil by the addition thereto of a mild antiseptic. This destroys certain soil pests and disturbs the equilibrium between protozoa and bacteria in the soil, enabling the latter to increase, and the bacteria produce available plant food with an increase in fertility.

THE MARINE ELEMENT IN THE FAUNA OF THE GANGES.—Dr. N. Annandale (reprint from Bijdragen tot de Dierkunde, K. Zool. Genootschap, Amsterdam, 1922, pp. 143-154) discusses the marine element in the fauna of the Ganges. He regards the Bay of Bengal, with its low salinity and gradual changes from salt water to fresh, as an exceptionally favourable starting-point for an immigration into fresh water on the part of marine organisms. An immigration of the kind has been in progress for a long period, and many adaptable euryhaline species are still attempting to establish themselves above the limits of tidal influence in fresh water. A very slight change either in the environment or in the constitution of the animals themselves would enable them to do so. The relict and euryhaline faunas of the Ganges represent different stages in this process of inland immigration, which has proved successful owing to the vigorous constitution of those organisms that have missed no accidental opportunity of establishing themselves in fresh water. In spite of superficial changes, a large proportion of both the relict and the euryhaline forms are of essentially primitive structure, or at any rate belong to ancient groups some of which have almost or completely disappeared from adjacent seas. In other words, fresh and brackish water have proved a last refuge for many marine species whose race in the sea was nearly done.

THE NON-MENDELIAN INHERITANCE OF SIZE CHARACTERS IN FLOWER PETALS.—Prof. R. R. Gates describes, in the *Journal of Genetics*, vol. 13, No. 1, March, the inheritance of petal size through four generations of reciprocal crosses between *Œnothera rubicalyx* and *Œ. biennis*. A more or less uniform F_1 generation is followed by wide segregation in F_2, not only between the size of petals in different plants, but even on the same plant and in some cases on the same flower. A close analysis of these flowers does not suggest frequency curves grouped around modes dependent upon different size factors, but rather haphazard distribution of sizes due to the failure of adjustment between different size tendencies inherited from the original cross. Such variation in size does not appear apart from the original cross, so that germinal factors are involved, but their representation is not possible, either in terms of normal Mendelian factors or in terms of the Galtonian curve for fluctuating variability. Prof. Gates suggests that the variable nature of these inherited tendencies, as exhibited within the individual, may arise through their partial dependence upon cytoplasmic characters of the parental forms.

THE OIL PALM UNDER CULTIVATION.—The oil palm, *Elæis guineensis*, occurs naturally in West Africa over an area lying between 12° N. and 12° S. of the equator. The fruit of the palm has an outer pulpy coat which contains some 50 per cent. oil and an inner kernel with about the same percentage of an oil of different composition. Both these oils are of commercial value, and G. G. Auchinleck, in Bulletin No. 62 of the Department of Agriculture, Ceylon, estimates that 300,000 tons of kernels and 100,000 tons of palm oil come on to the market annually. The French, English, and Belgians are in control in the various oil-producing areas of Africa, but the Dutch appear to be first in definitely undertaking the systematic plantation of the oil palm, some 28,000 acres being planted with this plant in Sumatra by 1922. If the somewhat uneven product and irregular supply from the palm's natural habitat can be replaced by a trustworthy product developed from a systematic plantation industry, the African palm-oil trade will meet with a formidable competitor. British planters in the East would probably do well to study Mr. Auchinleck's account of the oil palm and its product in this bulletin, and to watch the future history of the oil palms now planted at the Anuradhapura Experiment Station in Ceylon.

Urease.—A powerful enzyme, which has the property of causing the rapid conversion of urea into ammonium carbonate, has been found in many plant tissues, especially seeds. That of the soya bean is the best known. Dr. W. R. Fearon, in the *Biochemical Journal* (vol. 17, No. 1, 1923), shows that what urease does is to split urea into cyanic acid and ammonia. He has isolated cyanic acid from solutions of urea under the action of the enzyme. The enzyme has no other action; cyanic acid in the presence of water rapidly undergoes spontaneous hydrolysis into carbon dioxide and ammonia. The facts can only be satisfactorily explained on the cyclic formula for urea put forward by Werner; that is,



The decomposition of urea by acids, alkalies, or heat proceeds along the same lines. We see also why urease does not decompose ethyl-urea or methyl-urea, not because of the nature of the enzyme, but because these substances do not yield cyanic acid.

Valency of Boron.—We have received from the Koninklije Akademie van Wetenschappen te Amsterdam a reprint of an interesting paper on "The Valency of Boron," by Prof. J. Böeseken, from the point of view of atomic structure. He concludes that boron exhibits valencies of 3 and 5.

Separation of the Isotopes of Mercury.—A detailed account of the partial separation of the isotopes of mercury by evaporation in vacuum in a large steel apparatus is given by Harkins and Madorsky in the March issue of the Journal of the American Chemical Society. The atomic weights of the heavy and light fractions differ by 0·1 unit. The partial separation is still a long and somewhat laborious process, but the authors state that they have designed an apparatus which would give the same separation in about thirty hours. The heavy and light fractions are still mixtures of isotopes, six of which, according to Aston, exist in the case of mercury.

Weather at Hongkong during 1922.—The *Monthly Meteorological Bulletin* for December 1922 contains "detailed results of observations made at the Royal Observatory, Hongkong, and the daily weather reports from various stations in the Far East," prepared under the direction of Mr. T. F. Claxton. The part for December also contains an annual summary of the Hongkong observations for the year 1922 and gives the mean and extreme values of the principal meteorological elements, with the normal values for the period 1884–1918. Tracks of the typhoons and principal depressions which occurred in the Far East during the year 1922 are shown on two plates. At Hongkong the barometric pressure during 1922 ranged from 30·445 in. during November to 29·174 in. during August. The air temperature ranged from 93·1° F. in August to 43·7° F. in November. The monthly mean was highest in July and lowest in January, the mean temperature for the two months differing by 22° F. For the thirty-five years the highest temperature observed was 97·0° F. in August 1900, the lowest 32·0° F. in January 1893. The total rainfall in 1922 was 69·44 in., of which 17·54 in. fell in August, and rain fell on 154 days. The average total rainfall for the thirty-five years is 83·83 in., the average total rain in the four months May to August being 55·13 in. The greatest prevalence of wind is from the east. Values of magnetic elements are given for the year; the means were Declination (west) 0° 21′·5, Dip (north) 30° 46′·0, Horizontal Force (C.G.S. Unit) 0·37279, Vertical Force (C.G.S. Unit) 0·22194, Total Force (C.G.S. Unit) 0·43386. No mention is made on the title-page of the Bulletin that the results for the year and the cyclone tracks, as well as the averages for thirty-five years, are given, and a casual reader might overlook this information, which is of primary importance.

Egyptian Petroleum.—Heavy-grade Egyptian crude petroleum formed the subject of a paper by Mr. W. A. Guthrie read recently at the Institute of Petroleum Technologists. The oil chiefly discussed was the product of the well-known Hurghada (Rargada) wells, situated about 200 miles S.E. of Suez, on the western shore of the Gulf. This field was first developed in 1914, since when it has produced 1,201,868 metric tons of oil; its present output averages 3500 tons per week. Some proportion of the oil contains salt water up to 30 per cent., an emulsion which, though it has proved refractory to deal with, seems to respond to electrical dehydration treatment, a method not always commercially possible. The dry oil flashes below 45° F., and its s.g. ranges from 0·907 to 0·925. Its sulphur content varies from 0·5 per cent. to 2·22 per cent. (comparatively low), while it yields 10-11 per cent. asphalt and 7-8 per cent paraffin wax: hence it may be classed as a true mixed-base oil. Distilled in the ordinary way, the crude oil gives 8 per cent. benzine and 15 per cent. kerosene, the residue (above 290° C.) constituting 76 per cent. Both the benzine and kerosene can be refined to very high-grade products, while the residue is utilised for the production of solar or Diesel oil (43·2 per cent.), hard pitch (29·3 per cent.), and inferior fuel-oil. The inclusion of an appreciable quantity of paraffin wax in the pitch is considered by the author to be advantageous rather than deleterious to its use for road surfaces, since theoretically it should enhance chemical stability and render the material less liable to crumble or disintegrate under climatic variations or under ordinary wear and tear. The author dealt at some length with paraffin wax extraction, by no means an easy problem in this case, but this product actually finds little use within Egypt itself. One other interesting point mentioned in the paper was in connexion with the oil produced from the new field at Abu Durba, on the east shore of the Gulf; chemical and physical tests apparently show that this oil is an inspissated and oxygenated product of petroleum: it is of a very heavy asphaltic character and contains varying proportions of a waxy resin.

Museum Building at South Kensington.

THE latest chapter in the long history of museum building at South Kensington opened in 1909 when a large deputation of those interested in science and industry presented to the president of the Board of Education a memorial urging that the time had come for action with the view of providing proper housing for the Science Collections at South Kensington. The memorial, and the speakers who supported it personally, focussed the opinions of all the leading scientific and technical societies and institutions. Acting on the representations then made to him, the president of the Board of Education appointed in 1910 a "Departmental Committee on the Science Museum and the Geological Museum," with Sir Hugh Bell as Chairman. Three years later, the adoption of the report of that committee appeared to secure the early provision of adequate facilities for a well-directed advance in the usefulness of these museums.

Building operations were duly commenced, but were interrupted during the war period. Resumed later, they have made so little progress that representatives of the societies which originated the movement in 1909 have recently had occasion to consider the present position and to make a representation with regard to it. As the matter is one of wide interest, the following summary of its salient features may be of interest to those who are not familiar with the published papers that bear upon it.

THE SCIENCE MUSEUM.

For forty years the Science Collections have been developing on consistent lines. For more than twenty years they have been recognised as being, among national collections of the same field, the best museum collections in the world, but as having the meanest of museum buildings. It is now thirteen years since the appointment of Sir Hugh Bell's committee — a strong departmental committee of men versed in pure and applied science. That committee took careful measure of the possibilities and of the needs of the Science Museum, and formulated a well-considered and clear report upon the whole matter (Report, 1911, and Report, Part II., 1912).[1] This report received warm approval at all hands, and it was adopted by the Government as the basis for the development of the Museum. The first requirement to be met was necessarily the erection of adequate and worthy building accommodation.

In its report the committee quoted the exhibition space available in 1911 as 98,000 sq. ft. (94,000 sq. ft. in old buildings and 4000 sq. ft. in the new Western Hall), and said that buildings twice as large would be required for the then existing collections without the addition of a single specimen. The committee estimated at 265,000 sq. ft. the total exhibition space then required in new buildings, and recommended the provision of a building to occupy the ground available on the existing site, as shown on the accompanying plan (Fig. 1), this building to be erected in three successive sections, the eastern, the central, and the western blocks. The committee reported that the central as well as the eastern block would be required for the more immediate needs of the Museum.

In the programme for the replacement of the old

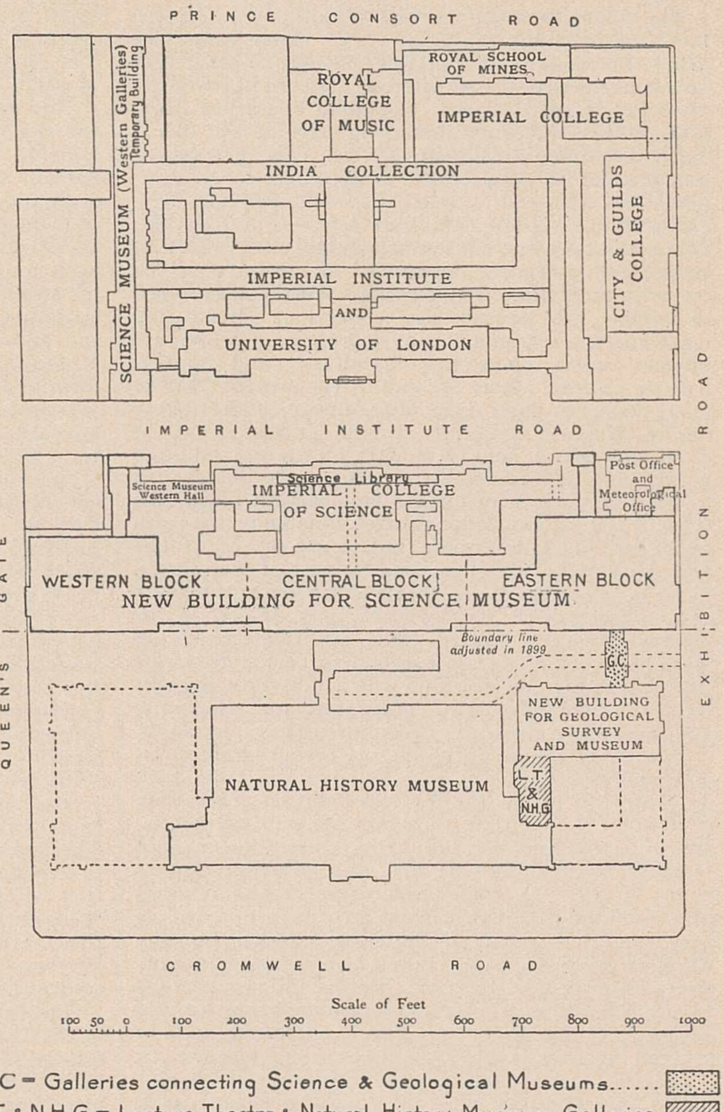


FIG. 1.

buildings by a continuous building occupying the whole of the Science Museum site from Exhibition Road to Queen's Gate, three periods in the process are distinguished. The *first period* covers the erection of the eastern block; this is the present period. In the *second period*, when the new central block will be in process of erection on ground cleared by the demolition of the main part of the existing old buildings, the eastern block of the new building with the existing western galleries and western hall "will afford opportunity for exhibiting the collections made during the first period and for working up the

[1] Report of the Departmental Committee on the Science Museum and the Geological Museum, 1911, Cd. 5625; (Part II.) 1912, Cd. 6221.

collections in all departments." The close of the second period will see both the eastern and central blocks of the new building fully available for the uses of the Museum and for the development of its collections. The committee contemplated a pause in the building operations at this stage. It said that during the *third period*, which will last till the western block is built, " the new eastern and central blocks with the existing western galleries, will afford a total accommodation that may be expected to suffice for all requirements until there is a clear call for the western block."

The first section of the new building—the eastern block—was commenced in 1913. Then came the War: the shell of the building was put to other uses and continued to be so appropriated for some years after peace was declared. Building operations have now, however, been resumed on part of the block, and this first instalment of the new permanent quarters for the collections is expected to be completed by the end of 1924. It will provide, say, 75,000 sq. ft. of new exhibition space—only one half of the total set-out for the complete eastern block of the " Bell " report. Moreover, it appears to be contemplated that the existing Western Galleries, in which are housed the collections illustrating mathematics, astronomy, physiography, meteorology, physics (part), chemistry, metallurgy and mining, will be vacated about the end of the present year to make room for part of the War Museum collections.

The Western Galleries provide 33,000 sq. ft. of exhibition space, and as a part of the old building which provided 20,000 sq. ft. had to be demolished in 1913 to make way for the new eastern block, the total of the *old* exhibition space available in 1925 will be 53,000 sq. ft. less than that in use in 1911. The *new* space to be added in 1924 by part of the eastern block is 75,000 sq. ft., so that the net increase in 1925 as compared with 1911 will be only 22,000 sq. ft. Meanwhile, quite apart from additions to other sections, accommodation has had to be found for the two important new sections which illustrate respectively aviation and wireless telegraphy and telephony, and these alone already occupy more than 12,000 sq. ft.

For all practical purposes, on the programme as now understood, the Science Museum will be in 1925 no better off in the matter of exhibition space than it was in 1911: that is to say, it will be still so grossly overcrowded that the collections cannot possibly be examined in the way museum objects ought to be. In these circumstances the obvious practical step is to put in hand for completion not, as now, merely one half of the eastern block, but the whole of the block that is not at present in temporary occupation by the Museum. Better still would it be to provide other temporary accommodation for the sections of the collections there exhibited and to proceed with the completion of the whole block.

Indeed, there must be certainty of active and continuous progress with the building scheme as a whole, for not until the central as well as the eastern block is completed will the Science Museum have any appreciable increase of space for its steadily growing collections. Yet it is doubtful if there ever was a time when the progress of science and invention required so much of museum exhibition or when the Museum could do so much to spread intelligent appreciation of the achievements of science and of its applications in industry.

The Museum of Practical Geology.

The terms of reference to Sir Hugh Bell's committee required the committee to consider and report upon the Geological Museum in Jermyn Street, as well as upon the Science Museum. On each it was to advise as to the purposes the collections should serve, the lines upon which they should be developed, and " as to the special characteristics which should be possessed by the new buildings which it is hoped will shortly be erected on the South Kensington site to house these collections."

As in the case of the Science Museum, so in that of the Geological Museum, the report with its appendices gives clear recommendations on these points. The committee shows the need for a larger building than the Jermyn Street site provides, and urges the advantages of bringing the Geological Museum into due relation with other museums at South Kensington. Yet ground has not been broken for a new Geological Museum building.

Now those passages in the report which deal with the Geological Museum are particularly helpful and hopeful, for it is evident that the committee gave special consideration to points affecting the co-ordination of the several national museums that are concerned with science, and that it saw the way to an effective and economical scheme by which, while each museum would preserve its individuality and its autonomy, its own organisation and responsible authority, all three—the Natural History Museum, the Museum of Practical Geology, and the Science Museum—might be grouped and worked so as to form jointly a complete and worthy national museum of science. The accomplishment of this ideal would be warmly welcomed by all workers in science no less than by students and the public at large.

The committee reported that the Geological Survey Offices and Library and the Museum of Practical Geology were cramped by the limitations of the building in Jermyn Street, and that if the necessary space could be allotted at South Kensington it would be of great advantage to have a building giving the required accommodation erected as part of the general scheme there. The committee pointed out that collections in the Science Museums represent the general principles of geology and geography by examples selected from all parts of the world, while the economic collections in the Museum of Practical Geology in Jermyn Street are arranged with special reference to the needs of the practical man and the technological student, and its stratigraphical collections deal specially with the geology of the British Isles. The committee added that if all these were housed in new buildings at South Kensington in communication with the systematic collection of minerals, and the palæontological collections arranged according to their natural affinities in the British Museum (Natural History), the series would represent at a single centre the whole field of geological science.

The committee further reported that the Trustees of the British Museum were willing that the building for the Museum of Practical Geology and the Offices and Library of the Geological Survey should be placed on the part of the site allotted to the Natural History Museum. The scheme provides that this building be erected in connexion with and as part, structurally, of the eastern extension of the Natural History Museum, when it comes to be built, and that it be brought into direct communication on its north side with the new Science Museum building by connecting galleries carried over the roadway which gives access to the back of the Natural History Museum. (See Fig. 1.)

The sketch plan submitted with the committee's report shows the new building for the Museum of Practical Geology and the Offices and Library of the Survey as a self-contained unit. This unit, however, communicates on the north with the Science Museum and its collections illustrating physical geology, physiography and geography, mining, metallurgy, and construction, while to the south it is in direct connexion with the mineral and palæontological collections of the Natural History Museum. The plan also shows in the related part of the Natural History Museum the position of a lecture room which the authorities of that Museum contemplate for joint use in connexion with their own Museum and with the Museum of Practical Geology.

There is no need to detail the many advantages of this scheme. They are obvious. It should be noted, however, that the limitations of space in the Jermyn Street building are no less harmful now than they were ten years ago. On the other hand, in the case of the geological section of the new buildings at South Kensington, financial considerations should not now present much difficulty, for the value of the Jermyn Street site would go far to balance the cost of providing the larger new building on the site designated for it.

It is worth while to quote here the concluding section of the 1911 Report of Sir Hugh Bell's committee:

"In other departments of knowledge, the British Museum and the Victoria and Albert Museum have set a high standard for the national provision of Museum facilities. In the domain of Science the requirements of most of the branches of Natural History are already admirably provided for at South Kensington in the Natural History Museum. In no way overlapping or duplicating the functions of these great institutions, but representing aspects of human activity which lie outside their scope, not less ample provision is necessary for those departments of knowledge, invention and discovery, the needs of which have been brought so vividly before us in our inquiry; and we are of opinion that no scheme for a national Science Museum can be regarded as satisfactory unless it provides the buildings necessary for affording to Science and the industries all the assistance a Museum can give. A Science Museum in which all branches of Physical Science, Pure and Applied, and the Scientific and Economic work of the Geological Survey shall be adequately illustrated in close proximity to the other great Museums at South Kensington will, we believe, be of incalculable benefit alike to intellectual progress and to industrial development, and will be recognised as an institution of which the country may well be proud."

Antarctic Geophysics.

THE two reports referred to below[1] are the records of the aurora observations and gravity determinations made during Capt. Scott's last south polar expedition, 1910–1913. They are both dated for 1921, but it was only in February of this year that they reached us.

The original plans for auroral observations on Capt. Scott's *Terra Nova* expedition included photographic determinations of the height of auroræ, using Prof. Störmer's method. This part of the programme unfortunately proved impossible to execute, owing to the lack of the necessary special lenses and photographic plates. The auroral spectrum also was not observed, so that the work accomplished consisted of visual observations, namely, sketches, brief descriptions, and times of occurrence of auroræ. These data are now summarised and discussed by Mr. C. S. Wright, himself a member of the scientific party. The sketches and daily log are not reproduced, but the plan of observation and the resulting data are described in general terms, discussed statistically, and finally considered in their theoretical bearing.

Observations were made at two stations, in what may be termed the Scott-Shackleton strip of the Antarctic coast. One was Cape Evans, 77·6° S., 166° E., and the other was Cape Adare, 71·3° S., 170° E. Both stations are thus within a few degrees of the south magnetic pole, but considerably farther from the pole of the earth's magnetic axis, Cape Adare being at the greater distance. The two stations are about 700 kilometres apart, and a horizontal plane through one station would, in consequence of the earth's curvature, pass over the other at a height of about 40 kilometres. Auroræ occur at heights of about 90 kilometres and upwards above the earth's surface, so that from either station, in clear weather, auroræ above, or even a little beyond, the other, would be visible low down on the horizon. The hills and mountains in the neighbourhood of Cape Evans obscure the free horizon in some directions, though the report does not indicate which these are, nor whether Cape Adare is similarly affected. This information, together with more detailed statistics as to the relative frequency of auroræ at different altitudes, would have added to the value of the report.

In many respects the auroral features at the two stations are strikingly dissimilar. Auroræ are far more frequent at Cape Adare than at Cape Evans, and also more distinguished by brilliance, colour, and motion. Cape Adare is therefore nearer to the region or belt of maximum auroral frequency than Cape Evans is. Moreover, the majority of auroræ visible from Cape Adare lie to the north, so that Cape Adare, and *a fortiori* Cape Evans, is situated within the belt. This has an interesting bearing on the size of the auroral belts; the Arctic auroral zone is generally supposed to have a radius of about 20°, and to be centred at the pole of the earth's magnetic axis. There is no very recent determination of the position of the pole, but it can scarcely have moved more than a degree or two from its position in 1885, the epoch of Adams's investigation. Cape Adare is 27° distant from this point, and as this angle is a lower limit for the radius of the belt, this radius would seem to be greater than was to be expected.

The auroræ visible from Cape Adare, since they lie to the north, must for the most part be less than 3° above the horizon of Cape Evans. Consequently the auroræ seen from the latter station must in the main be different from the former. They represent conditions some degrees within the belt, and they differ in number and brilliance from those near the belt. They appear most frequently in a direction slightly north of east, and least often in the west. Again, whereas the Cape Adare auroræ trend predominantly east and west, or rather from a little north of west to a little south of east, the Cape Evans auroræ show a marked avoidance of the east-west trend. In each case the trend is perpendicular to the direction in which auroræ are least frequently seen. Brightly coloured and quickly moving auroræ are rare at Cape Evans, but fairly common at Cape Adare.

Auroræ were seen at Cape Evans on about one day out of three when seeing conditions were favourable, and about twice as often at Cape Adare. At either station they usually appear first at a low altitude in the direction of maximum frequency, and move

[1] British (*Terra Nova*) Antarctic Expedition, 1910–1913. Observations on the Aurora. By C. S. Wright. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. viii+48. (London: Harrison and Sons, Ltd., 1921.) 7*s.* 6*d.* net.

upwards, approaching the station, sometimes passing overhead and, after an interval, vanishing while in the region of minimum frequency. The overhead passage was much more common at Cape Adare than at Cape Evans.

The auroræ show a well-marked tendency to occur most often in the early morning, round about 4 A.M. local time. A secondary maximum occurs at Cape Adare at 8 P.M., and a trace of it is apparent also at Cape Evans. In the afternoon the auroræ rarely pass overhead, but they are more often brilliantly coloured and of swift motion than those which occur in the morning. At times of maximum frequency the aurora is also generally of greatest extent.

In the magnetic report of the expedition, by Dr. Chree, the connexion between magnetic activity and the aurora has already been discussed; Mr. Wright here carries the discussion further. It is clear that there is some relation between the two phenomena, though it is not so evident as in latitudes farther from the pole, where auroræ are seen only rarely, and are always accompanied by magnetic storms. Mr. Wright shows, however, that there is a marked correspondence between the magnetic character of a period of several hours about the time of appearance of a brilliant aurora, and the intensity of the aurora; the relationship is much more close than that between the same two characteristics at individual hours. Some of the results of this report had been anticipated by Mawson's report (1908) on the auroral work of the Shackleton expedition, though the latter is not confirmed in all respects. The auroral station in the Shackleton expedition was not far from Cape Evans.

These valuable memoirs will become of still greater significance and importance if and when another south polar expedition conducts similar observations in a part of the Antarctic considerably different in longitude from the Scott-Shackleton region, but at a similar distance from the pole of the earth's magnetic axis.

Mr. C. S. Wright's report [2] on the gravity observations, for which he was responsible, made during the *Terra Nova* expedition, is a record of a most manful struggle against difficulties. It seems very regrettable that the instrumental equipment of the expedition was not of the highest quality, for observations in the Antarctic are sufficiently exacting even under the best conditions. As a matter of fact, some of the equipment for Mr. Wright's gravity work was very bad, particularly the old transit circle on which he had to rely for his clock rates.

Four series of observations were made at Cape Evans, the first two being made in a cave cut in snow-drift consolidated to ice. The cave being small, the temperature varied by 10° C. during the time of observation, due to the observer's presence; all the mirror and lens surfaces were frosted by his breath, and also the prisms, agate planes, and pendulums themselves. A fortnight's break in the series of observations for each determination of *g* was made in order to allow the mirrors to clear. Notwithstanding all the efforts made to meet these conditions, the first two series gave such discordant results that in the second year a change was decided upon.

Attempts were made to build a small observing hut of (full) petrol cases covered with rubberoid and canvas; the hut was to be heated artificially during the observations. Twice the nearly completed hut was demolished by blizzards, and when at last it was securely built and banked with snow, it had to be abandoned after some days' trial, as it was found impossible to maintain it at a workable temperature, or even to keep it free from drift snow. Finally, the photographic dark-room opening off the living hut was lent as an observing station. Two series of observations were made here, in July and August 1912; the last series was not so good as that made in July, probably owing to the whole hut being shaken by blizzards during the August determination. Rejecting the results obtained in the previous year, the mean value of *g* from the three pendulums used in 1912 at Cape Evans was 983·003 from the July series and 983·004 from the August series: the probable error of the final mean is given as 0·0023 cm./sec.^{2}. Commdr. Bernacchi, who on Scott's earlier expedition was faced with even greater difficulties in some respects, obtained the values 982·970, 982·979, and 983·025 from his three pendulums, at a spot fifteen miles farther south. These values may be compared with the standard value 981·292 at Potsdam, which was taken as the reference or base station for the gravity work, and where Mr. Wright received training and much help from Prof. Helmert and his staff at the Geodetic Institute.

Observations were also made at Wellington, Melbourne, and Christchurch, in the latter case both on the outward and return journey. The value of *g* had already been accurately observed at Melbourne by Hecker in 1904 and Alessio in 1905, who obtained accordant values 980·003; the value found by Mr. Wright was 980·009, the difference exceeding the sum of the probable errors in the two cases: no reason for the disagreement can be assigned. The observations at Christchurch, like those made there earlier by Bernacchi, were unfortunately not very successful or accordant. The observation at Wellington was the first that had been attempted there. The check observation at Potsdam at the end of the expedition agreed well with the initial determination made with the same pendulums.

[2] British (*Terra Nova*) Antarctic Expedition, 1910–1913. Determinations of Gravity. By C. S. Wright. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. 106+4 plates. (London: Harrison and Sons, Ltd., 1921.) 7*s*. 6*d*. net.

Industrial Fatigue Research.

THE third annual report of the Industrial Fatigue Research Board (H.M. Stationery Office, price 2*s*. net) is even more interesting than those which have preceded it. It contains not only an account of the constitution, organisation, investigations, researches, external relations, and publications of the Board, but also nearly fifty pages of original contributions from five of its investigators—Mr. Farmer, Miss May Smith, Mr. Wyatt, Dr. Vernon, and Mr. Weston.

During its three years of activity the Board has published twenty-three reports—seven on general industrial problems, seven on the textile industries, five on the metal industries, two on the boot and shoe industry, one on the pottery industry, and one on the laundry trade. "More recently, however, and pending development of some scheme of actual co-operation with industries . . . the Board have tended to modify their original procedure, and have taken as their objective the study of certain general subjects, not confined to any one industry but of common interest to all, following up each subject along lines which experience shows to be most promising and dealing with it both by field investigation and by laboratory research."

The scientific committees under the Board accordingly comprise those for industrial health statistics, physiology of muscular work, physiology of the respiratory and the cardio-vascular systems, and industrial psychology. In addition to its five industrial committees, dealing respectively with the textile, metal, pottery and glass industries, and with industries specially affecting women, the Board has appointed two special committees, one concerned with Post Office work (more particularly the study of telegraphists' cramp), the other with Legibility of Type, in accordance with the recommendation of a committee "appointed by a Treasury Minute to select the best faces of type and modes of display for Government publication."

In this short notice it is impossible to do more than quote the titles of the interesting essays contributed to the report by the Board's Investigators; they are—"Some Considerations concerning Technique," "The Use of the Sample in Investigation," "Some Observations on Industrial Conditions, with Special Reference to Cotton Weaving," "Atmospheric Conditions and Industrial Efficiency," "Future Investigations in the Pottery Industry," "A Note on Machine Design in Relation to the Operative."

British University Statistics, 1921–22.[1]

THE most noticeable feature of the University Grants Committee's new blue-book is that it contains only 20 pages, whereas the returns for 1920–21 covered 391. The Committee proposes to issue a fuller publication on the old lines from time to time, say once in five years. In the intervals the public will be the more dependent for information on the Universities Yearbook. Oxford and Cambridge are not yet included in the returns, as their grants were "special emergency" and not regular grants. Excluding ex-Service students (8000 in 1921–22; 11,512 in 1920–21) the returns show, compared with those for the preceding year, increases of 2234, or 14 per cent., in the number of full-time men students, and 699, or 7 per cent., in the number of women students. The Committee points out that the numbers in England and Wales are about double what they were in 1913–14, and that the comparative smallness of the increase in Scotland (35 per cent.) was "no doubt due to the fact that the war found what may be called the 'university habit' already firmly established there by long tradition, assisted since 1901 by the operations of the Carnegie Trust."

Of the total number of full-time students, 93 per cent. had their homes within the United Kingdom, 58 per cent. within 30 miles from the university or college; of the remainder, 5 per cent. came from other parts of the Empire and 2 per cent. from foreign countries. Students from parts of the Empire outside the United Kingdom constituted 8 per cent. of the full-time students in London and 7 per cent. of those in Scottish institutions. Of full-time men students 6 per cent., and of women 28½ per cent., lived in Halls of Residence. The percentages of students in Halls of Residence in London, other parts of England, Wales, and Scotland were 11, 18, 23, and 5 respectively. Full-time students admitted for the first time in 1921–22 numbered 9249, including 3421 women; 52 per cent. were not less than 19 years of age, 28 per cent. were not less than 18, and 2⅝ per cent. were less than 17.

Three-fourths of the full-time students were following courses leading to first degrees, and 4½ per cent. were engaged in post-graduate study or research. Part-time students numbered 14,462, of whom 9455 were occasional students, 1126 were preparing for first degrees, and 2008 were graduate students or research workers. In addition there were 14,345 students taking courses not of a university standard.

Full-time students of medicine, including dentistry, numbered 11,612 (women, 2595)—nearly 32 per cent. of the total; 33 per cent. (men 5805, women 6252) were enrolled in faculties of arts, theology, law, music, commerce, economics and education; 2½ per cent. (men 758, women 123) were engaged in the study of agriculture, forestry, horticulture and dairying; and the remainder were equally divided between pure science (men 4295, women 1851) and technology (men 6019, women 68).

The number of first degrees obtained was 6352, including 2573 honours degrees; the number of higher degrees, 843.

The statistics of income were summarised and commented on in the article published in NATURE of May 26 on the Universities Conference. Of the expenditure (3,565,375*l.*), 10 per cent. was for administration, 49·3 per cent. for salaries of teaching staff, 13·4 per cent. for other expenses of departmental maintenance, 13·1 for maintenance of premises. Of income, 10·3 per cent. was from endowments, 2·7 per cent. from donations and subscriptions, 35·3 per cent. from parliamentary grants, 35·7 from tuition and examination fees. Recurrent grants from the Treasury amounted to 1,070,082*l.*, non-recurrent to 271,250*l.*, in addition to which there were special grants amounting to 499,400*l.* to provide retrospective superannuation benefit.

FULL-TIME STUDENTS IN VARIOUS FACULTIES IN 1913–14 AND IN 1921–22.

	London.	England, including London.	Wales.	Scotland.
All faculties—				
1913–14	3,874	10,023	1,230	8,419
*1921–22	7,208	20,065	2,712	..
1921–22	9,380	22,524	2,850	11,409
Pure Science—				
1913–14	441	1,620	234	655
*1921–22	1,177	3,925	721	..
1921–22	1,685	4,433	767	946
Medicine, including dentistry—				
1913–14	2,011	3,226	42	2,283
*1921–22	3,326	6,462	254	..
1921–22	3,943	7,079	260	4,273
Technology—				
1913–14	290	1,544	78	1,051
*1921–22	562	3,433	176	..
1921–22	†1,280	4,151	226	‡1,710
Agriculture, etc.—				
1913–14	..	221	58	140
*1921–22	..	298	110	..
1921–22	..	‖298	110	473

* Excluding the institutions which, not being then in receipt of grants, were not shown in the returns for 1913–14.

† Including 718 in Imperial College, South Kensington.

‡ Including 649 in the University of Glasgow and 707 in the Royal Technical College, Glasgow.

‖ Including 62 at Armstrong College, Newcastle-upon-Tyne, 60 at the University of Leeds, and 176 (82 women) at University College, Reading.

University and Educational Intelligence.

ABERDEEN.—For a number of years the hospital accommodation of Aberdeen has been insufficient, and the city has now before it a bold and comprehensive plan for remedying this defect. Originating with the Aberdeen Medico-Chirurgical Society some three years ago, the scheme has been elaborated by a committee

[1] University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant, 1921–1922. Pp. 20. (London: H.M. Stationery Office, 1923.) 3*s.* 6*d.* net.

representative of the various bodies concerned, including the directors of the Royal Infirmary, the directors of the Royal Hospital for Sick Children, and the University. It is proposed to utilise a site of more than 110 acres on the Town Council's properties of Burnside and Foresterhill, on the north-western outskirts of the city. The University on its part would build departments of medicine, surgery, midwifery, pathology, bacteriology, and pharmacology, with adjoining students' hostels. The teaching of these subjects would be removed from Marischal College, and the latter part of the medical course would be passed in immediate touch with the wards. The scheme has been in existence for about three years, but has not been pressed. The other bodies concerned having expressed their readiness to proceed, the matter is now before the Town Council. The difficulties in the way of the scheme are chiefly financial, a sum of about three-quarters of a million being involved. The advantages to the public served by the hospitals and to the teaching of medicine in the north of Scotland are incalculable.

CAMBRIDGE.—Dr. A. B. Appleton, Downing College, Mr. D. G. Reid, Trinity College, Mr. A. Hopkinson, Emmanuel College, and Mr. V. C. Pennell, Pembroke College, have been re-appointed demonstrators in anatomy. The Harkness scholarship has been divided between E. R. Gee, Trinity College, and W. D. West, St. John's College. Frank Smart prizes have been awarded to T. A. Bennet-Clark, Trinity College, for botany, and to A. D. Hobson, Christ's College, and L. H. Matthews, King's College, for zoology. The Wiltshire prize has been awarded to F. C. Phillips, Corpus Christi College.

At the recent conferment of honorary degrees on the Prime Minister, Viscount Grey, Lord Plumer, Sir Aston Webb, Mr. M. C. Norman, Prof. H. A. Lorentz, Dr. W. H. Welch, and Prof. N. Bohr, the Public Orator spoke as follows in introducing the three honorary graduates in science:

"Inter speculatores omnes venatoresque Naturae quos hodie physicos proprie vocamus, constat illum eminere quem iam ad vos duco. Admodum iuvenis Physicis professor constitutus, diu in Universitate Lugduno-Batava docuit, immo vero rude donatus adhuc docet, physicorum ipse Nestor. Multa linguarum scientia, multa rerum cognitione, miro ingenii acumine, talis est studiorum hortator, ut illis qui Naturae secreta explorant etiam si non adhuc penitus inveniunt verbo exemplo benignitate praecipue subveniat. Longam iam virorum seriem recolimus qui, post reformatam Ecclesiam et Lugduni constitutam Academiam, vitae Brittanicae Batavi lucem porrexerunt. Hodie lucis ipsius investigatorem honoramus qui nobis qua ratione inter se lux et vis electrica congruant et cohaereant exposuit. Si Academiae nostrae laudes hospiti nostro narrarem nonne verba illa primum arriperem, 'Hinc lucem'? et cum hospitem Universitati vestrae praesento, quid nisi eadem mihi succurrunt, 'Hinc lucem'? Duco ad vos Henricum Antonium Lorentz.

"Revocamus illum qui, apud Vergilium, augurio spreto, neglecta cithara, fama militari recusata,

ut depositi proferret fata parentis,
scire potestates herbarum usumque medendi
maluit et mutas agitare inglorius artes.

Eandem et hodie generis humani curam, eundem medendi amorem, easdem artes agnoscimus, sed non illum inglorium vocamus, qui vitam totam medicinae consecravit, qui discipulos usum illum plurimos docuit, qui non contentus translaticiam tradere scientiam secreta Naturae voluit ipse explorare et

venienti occurrere morbo.

Virum talem vobis praesento, Yalensem, in illa republica natum quae reipublicae normam dedit ampliori, multorum in Academia Baltimorensi doctorem, diu honoratum, diu amatum, necnon et Templi illius quod Novi Eboraci posuit Hygeae Propugnatrici Rockefeller, Flaminem Rectorem Archiatrum. Duco ad vos Willelmum Henricum Welch.

"Iterum inter nos praesentem salutamus alumnum et condiscipulum qui Danus, patre natus physiologo clarissimo, in rebus physicis ipse versatus, Angliam admodum iuvenis petiit, et ad Canum et apud Mancunienses et didicit et docuit. Illud laeti revocamus, quod apud Anglos primo investigavit quomodo re vera emittatur lux, quod cum patefecisset, atomi structura quae diu latebat magis intelligebatur. Hos tantos labores praemio Nobeliano coronatos quis mirabitur? sed ex eis quae scientiae speranda sint incrementa, quis divinabit? Quippe ad patriam reverso civium voluntate—quod ceteris gentibus exemplo sit!—facultas datur ut haec studia discipulis adiuvantibus libere prosequatur. Duco ad vos Niels Bohr."

EDINBURGH.—An anonymous donor has given the University a sum of 20,000*l.* to form the nucleus of a fund to provide a new Department of Zoology. In his letter to the Principal, Sir Alfred Ewing, the donor referred to the inadequacy of the present laboratories and to the serious disadvantages under which teaching and research in zoology are being carried on in Edinburgh, and stated that he hoped other support would be forthcoming so that the new Department might be erected in the near future.

The building in which the teaching of zoology is at present carried on forms part of the Old College, and was altered in 1882, so far as structural conditions would permit, in the endeavour to meet the needs of that time. Since then there has been a great development in the subject and in the methods by which it is taught, calling especially for more laboratory accommodation and better lighting, and in both these respects the present premises are wholly inadequate to meet the needs of the students—science and medical—and of the post-graduate workers in the Department. In addition to providing instruction for science students extending over four years, and for medical students in their first year, the work of the Department includes post-graduate courses in medical entomology, protozoology, and helminthology, for the diploma in tropical medicine and in public health. The accommodation in the existing premises, barely sufficient to meet the needs of forty years ago, has been hopelessly overtaxed during the last twenty years, and no alteration of the present building can remedy the defect. Strong hopes are entertained that the recent generous gift will be supplemented, and that the University Court will be able at an early date to proceed with the erection of the laboratories urgently needed for teaching and for research.

LEEDS.—Huddersfield Town Council has decided to make a contribution of 1000*l.* a year towards the maintenance of the University.

The following appointments have been made: Mr. George R. Ross to be lecturer in bacteriology, and Mr. R. Stoneley to be assistant lecturer in applied mathematics.

Prof. Jamieson has been appointed pro-vice-chancellor for a period of two years from July 1 in succession to Prof. A. Smithells.

LONDON.—At a meeting of the senate on June 20 the following appointments were made:—

Prof. F. Wood Jones, to the University chair of anatomy tenable at St. Bartholomew's Hospital

Medical College. Prof. Jones has been demonstrator and lecturer in anatomy at the medical schools in London and Manchester, and since 1919 he has been professor of anatomy in the University of Adelaide. He is the author of "Arboreal Man," "The Principles of Anatomy as seen in the Hand," and numerous other publications.

Mr. E. C. Williams, to the Ramsay Memorial chair of chemical engineering tenable at University College. Mr. Williams was awarded the Dalton chemical scholarship for research at Manchester, and he has since been on the scientific staff of the British Dyes, Ltd., and head of the department for the manufacture of intermediate products under the British Dyestuffs Corporation. Since 1921 he has been research chemist to the joint research committee of the University of Leeds and the National Benzol Association.

Dr. R. J. S. McDowall, to the University chair of physiology tenable at King's College. Dr. McDowall was lecturer in physiology at Edinburgh, and, since 1921, lecturer in experimental physiology and experimental pharmacology at Leeds. He is the author of publications on mammalian muscle, pulmonary circulation, and numerous other physiological subjects.

Mr. G. Stead, to the University readership in physics tenable at Guy's Hospital Medical School. Mr. Stead has been, since 1910, assistant demonstrator in the Cavendish Laboratory, Cambridge, and is the author of numerous publications embodying the results of research on the passage of electricity through gases.

The following doctorates were conferred: *D.Sc.* (*Engineering*): Mr. J. V. Howard (University College), for a thesis entitled "The Tension Test in relation to the Composition of Steel"; and Mr. S. L. Smith (Imperial College—City and Guilds College), for a thesis entitled "Mechanical Hysteresis and Tensile Deformation of Steel."

MANCHESTER.—The Sir Clement Royds memorial scholarship in chemistry of the value of 300*l.* is being offered to candidates born or resident in the county of Lancaster, preference being given to the county borough of Rochdale. Further particulars are obtainable from the Internal Registrar, to whom applications must be sent by, at latest, July 14.

Dr. H. S. Raper has been appointed Brackenbury professor of physiology and director of the Physiological Laboratories. Dr. Raper, who is at present professor of physiology and biochemistry in the University of Leeds, was engaged in research work during the War on protection against poison gas, and from 1918 was head of the Anti-Gas Department. He is at present retained by the War Office in an advisory capacity on physiological questions arising in connexion with chemical warfare.

The following additional appointments have also been made: Dr. T. M. Bride to be chemical lecturer in ophthalmology; Miss Irene J. Curnow to be assistant lecturer in geography; Mr. David Stewart to be assistant lecturer in anatomy; Mr. E. V. Ashcroft and Miss Eugenia R. A. Cooper to be demonstrators in anatomy; and Mr. W. H. Wood to be tutor and secretary to the Faculty of Medicine.

THE examination for the Aitchison memorial scholarship, value 36*l.*, covering the full-time day courses in technical optics at the Northampton Polytechnic Institute, extending over two years, will be held on September 25-26 next. It is open to candidates of both sexes. Full particulars can be obtained from the Hon. Secretary and Treasurer, Mr. H. F. Purser, 35 Charles Street, Hatton Garden, E.C.1.

APPLICATIONS for grants for 1924 from the Van 't Hoff Fund, which are made to investigators in the fields of pure and applied chemistry, must be sent before November 1 by registered post to: Het Bestuur der Koninklyke Akademie van Wetenschappen; bestemd voor de Commissie van het "Van 't Hoff-fonds," Trippenhuis, Kloveniersburgwal, te Amsterdam. A detailed account of the proposed use of the grant, and of the reasons on which the candidate bases his claim, should accompany the application. The amount available for 1924 is about 1400 Dutch florins.

THE Commissioners for the Exhibition of 1851 announce that Senior Studentships for 1923 have been awarded to the following: Dr. W. Davies, demonstrator and lecturer in chemistry at the University of Oxford; Dr. L. C. Jackson, science research scholar in physics of the Royal Commission of 1851, at the University of Leyden; Mr. J. H. Quastel, research student in bio-chemistry at the University of Cambridge; Mr. D. Stockdale, research student in metallurgy in the Goldsmiths' laboratory at the University of Cambridge, and demonstrator in the University Chemical Laboratory; and Mr. H. Williams, research student in geology at the University of Liverpool.

ON June 22, the Universities of Oxford and Cambridge Bill was before the House of Commons, and the second reading was agreed to without a division. It will be remembered that the Bill is a result of the report of the Royal Commission appointed in November 1919 to investigate financial and other conditions at Oxford and Cambridge. Under its provisions, two bodies of commissioners will be appointed, of which Lord Chelmsford and Lord Ullswater are to be the respective chairmen, to direct affairs in the Universities for five years. There is also provision for financial aid for each University; the Royal Commission suggested an annual grant of at least 70,000*l.* in addition to the 30,000*l.* already received annually by Oxford and Cambridge.

THE excessive prolongation of merely preparatory general education is trenchantly criticised in the annual report for 1922 of the Carnegie Foundation for the Advancement of Teaching. It is pointed out that the "High School" was intended originally to form for the common people of the country a college in which their sons and daughters might be prepared for various practical callings just as the college proper prepared its students for the learned professions. The high school and college offered in fact *parallel* modes of education. The high school gradually came under the complete domination of the academic colleges and universities until the former became, what it is in large measure to-day, a vestibule to the college, even though but a small number of its students proceed to college. There has resulted an "Educational pyramid" comprising 8 years in the elementary school (from age 6 to age 14), 4 years in the high school, and 4 years in college—in all 16 years of preparatory training in schools the primary purpose of which is assumed to be cultural. "The like of this is not to be seen in any other part of the world. . . . Without question 4 years can be dropped out of the programme with advantage to the cause of education and to the interest of the people and of their children. But this change also is clearly related to that conception of education which assumes that the beginning of education lies in the sincere learning of a few things rather than in the superficial acquaintance with many."

Societies and Academies.

LONDON.

Royal Microscopical Society (Industrial Applications Section), May 30.—Dr. A. Hutchinson in the chair.—H. B. **Milner**: The microscopical investigation of sands for various industrial purposes. The application of the petrological microscope to the discrimination of sands and allied rocks suited to various industrial requirements, such as glass manufacture, abrasives, ferrous and non-ferrous foundry work, silica-brick production, cement, mortar, concrete, brick and tile manufacture, and as a source of economically valuable minerals such as monazite and thorianite for incandescent gas mantles, etc., was discussed. The distinctive properties of sands for their proper utilisation in the arts can be determined by the microscope. The employment of the microscope should not be interpreted as a certain cure for all technical difficulties, but the full possibilities of the instrument are still unappreciated by the majority of manufacturers who employed refractory materials. Lines of microscopical research on refractory sands, particularly in connexion with silica-bricks, were suggested.

Aristotelian Society, June 4.—Prof. A. N. Whitehead, president, in the chair.—Sir Leslie **Mackenzie**: What does Dr. Whitehead mean by "event"? The word has a peculiar importance in his theory. It is intended to cover the fact that, on whatever theory we finally decide as to the nature of the physical world, that world cannot now be described or even discussed except abstractly if we confine ourselves to terms of space alone; for space and time have a common root, and, if we speak in terms of space alone, we can properly do so only in one of two ways: either we must use space as meaning space-time or simply as a second grade of abstraction. In either case it omits the essential point that the physical world is to be taken in terms of space and time in unity. At first sight, the word "event" seems to overstress the time element. The fact of a happening is thought of first in terms of time and not in terms of space. But it is something perceptible that happens, and if it took no time to happen, it would not be perceptible; for it would be nothing at all. Time, therefore, is of the essence of every happening. But equally there is no doubt that what happens physically happens in a space, it happens somewhere, and every physical happening must be thought of as also in space. Whether explicitly so understood or not, every event in the physical world is, therefore, a thing to be thought of as involving both time and space.

Geological Society, June 6.—Prof. W. W. Watts, vice-president, in the chair.—H. **Bolton**: On a new blattoid wing from the Harrow Hill mine, Drybrook (Forest of Dean). The wing is a right fore-wing of a new genus of blattoid, and of unusual size. The surface is densely chitinous, and crossed by a series of powerful well-branched veins, the cubitus being especially well developed, and much unlike any other known among the Coal-Measure blattoids. The insect probably occupied an intermediate position between the families Archimylacridæ and Hemimylacridæ. — C. E. **Tilley**: Contact - metamorphism in the Comrie area of the Perthshire Highlands. The thermal aureole of the Cairn Chois diorite-complex is divisible into (*a*) zone of biotite and (*b*) zone of cordierite, which rapidly passes into a zone of true hornfelses. In the Aberfoyle-Slate band, an additional outer zone (zone of spotted slates) is found; but no chemical reconstruction is apparent. The progression of metamorphism as here observed is that distinctive of kaolin-free slates subject to thermal alteration. The rocks of the hornfels zone—with a minimum width of 150 yards—show a wide range of composition. A classification of the silica-poor hornfelses is suggested, starting from a simplified system of four components. The mineralogical assemblages thus ideally determined can be alternatively developed from a consideration of the chemical changes incident on metamorphism of sericite-chlorite-quartz assemblages of the original rocks. Certain abnormal assemblages are considered as unstable. These, while not invalidating the hornfels classification adopted, serve to indicate that equilibrium in the inner contact-zone is closely approached rather than completely attained.

Linnean Society, June 7.—Dr. A. B. Rendle, president, in the chair.—H. **Sandon**: Some Protozoa from the soils and mosses of Spitsbergen obtained by the Oxford University Expedition.—J. D. F. **Gilchrist**: A form of dimorphism and asexual reproduction in *Ptychodera capensis*. C. E. **Moss**: The species and forms of Salicornia in South Africa.—J. **Burtt-Davy**: Geographical distribution of some Transvaal Leguminosæ. The Leguminosæ form the largest family of Transvaal Spermatophyta, as regards numbers of species, having about 100 species more than the Compositæ, and comprising nearly 10 per cent. of the recorded species of the flora. A large number of the genera have very few species. The greatest number of endemics generally occur in genera with the greatest number of species; and the species show great variation in range. Even in the same genus some range almost the length of the Continent. Classified according to their geographical range of distribution, the Papilionaceæ fall into five very distinct groups: (1) the South-western Cape Province element, (2) the Kalahari element, (3) the Rain-forest element of the eastern high mountains, (4) the Tropical African element, and (5) the Warm Temperate Plateau element. (4) and (5) account for 94 per cent. (306 species) of the total Papilionaceous flora and 123 are endemic to the Transvaal. Adding to these species those which range into the states bordering on the Transvaal but not beyond them, the number of endemics forms 78 per cent. of the population. Fifteen species (less than 5 per cent.) are common to the Transvaal and India, and five species are found in Madagascar. In connexion with the view that arborescent forms are the older types, it is noteworthy that, with one exception, possibly introduced, the arborescent and shrubby species of Papilionaceæ (only about twenty in all) belong to the Tropical African element, and about half of them belong to genera with few species. —C. E. **Moss**: Velaminous roots in terrestrial orchids. They are especially noticeable in the orchid genus Eulophia, abundant at the Cape (S.A.).

Physical Society, June 8.—Dr. Alexander Russell in the chair.—J. G. **Gray**: A general solution of the problem of finding the true vertical for all types of marine and aerial craft. The difficulties presented by this problem arise from the horizontal accelerations which result from the turning of vehicles. A gyroscopic pendulum to succeed must possess a real precessional period, or a virtual precessional period during turning motion of the vehicle on which it is mounted, which is measured in hours. Pioneer forms of Gray stabiliser comprise a single gyroscope, mounted with its axis normally vertical, and an erector connected rigidly to it; the whole is pivoted to a gimbal frame by means of two cross pivots. One form of erector consists of a circular track carried by the pivoted system, and so arranged that when the pivoted system is upright the track is horizontal. One, two, or more balls rotate on the track, each controlled by a pusher and a check carried by a member which rotates slowly (about 12 revolutions per minute) in the direction of spin of the gyroscope. When the system is upright the balls move round the track in contact with their pushers, and form a balanced system. When the system is inclined to the vertical the track is inclined to the horizontal, and each ball when ascending the slope of the track rests against its pusher, but after crossing the crest of the slope it is accelerated down the track and rests against its check. The motion of the balls relative to the pushers and checks results in the application to the pivoted system of an integral erecting couple. Such instruments possess an accuracy, for bombing purposes, amounting to one-eighth or one-tenth of a degree, or about 20 feet on the ground from a height of 12,000 feet. Later forms of Gray stabiliser set themselves into the true vertical even when the vehicles on which they are mounted are turning, and this holds for all speeds of turning. This result is obtained by constructing the apparatus so that a horizontal component of spin lies across the pivoted system, which is mounted so as to be pendulous with respect to the pivots. The direction of the horizontal spin, and its amount, are arranged so that when the vehicle turns there comes into existence a gyroscopic couple, applied about the fore and aft pivots, which is exactly equal and opposite to the so-called centrifugal couple applied to the pivoted system. Both couples are proportional to the angular speed at which the vehicle turns, and both change sign with that of the turning motion.

Zoological Society, June 12.—Sir S. F. Harmer, vice-president, in the chair.—N. A. **Mackintosh**: The chondrocranium of the teleostean fish *Sebastes marinus*.—R. I. **Pocock**: The external characters of the pigmy hippopotamus (*Chœropsis liberiensis*) and of the Suidæ and Camelidæ.—E. E. **Austen**: A revision of the family Pantophthalmidæ (Diptera), with descriptions of new species and a new genus.—Raymond **Dart** and C. W. **Andrews**: The brain of the Zeuglodontidæ (Cetacea), with a note on the skulls from which the endocranial casts were taken.—R. **Broom**: On the structure of the skull in the carnivorous dinocephalian reptiles.—Oldfield **Thomas** and M. A. C. **Hinton**: On mammals collected by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to Orange River.

Paris.

Academy of Sciences, June 4.—M. Albin Haller in the chair.—Charles **Richet**: The function of the spleen in nutrition. An account of some feeding experiments on dogs after removal of the spleen.—Gabriel **Bertrand** and Mlle. S. **Benoist**: A new sugar, procellose. Filter paper is converted into cellulose octacetate by the method of Maquenne and Goodwin, and the mother liquors from the crystallisation of this acetate worked up for the isolation of the new sugar, to which the name procellose is given. Its composition is $C_{18}H_{32}O_{16}$ and rotation $[\alpha]_D = +22°\cdot 8$ at 21° C.; its reducing power is half that of glucose. Its probable formula is given.—C. **Guichard**: Two triple orthogonal systems which correspond in such a manner that the first tangents to the two systems are reciprocal polars with respect to a linear complex.—Sir Richard Hadfield was elected corresponding member for the section of chemistry in succession to M. Paterno, elected foreign associate.—René Maire was elected corresponding member for the section of botany in succession to the late M. Battandier.—Jules **Drach**: Remarkable classes of W congruences.—Bertrand **Gambier**: The curves of Bertrand, and in particular, those which are algebraical.—MM. **Schouten** and **Struik**: A theorem of conformal transformation in differential geometry of n dimensions.—M. **Lainé**: The integration of differential equations.—Serge **Bernstein**: A property of integral functions.—Henri **Eyraud**: Multiple spaces and tensors.—M. **Chatillon**: The paramagnetism of cobalt sulphate in aqueous solution. An explanation of the divergent results of Cabrera and Trümpler on the coefficient of magnetisation of cobalt salts. With solutions prepared at ordinary temperatures, the results are independent of the concentration, but if the solutions are prepared hot and allowed to cool to the ordinary temperature, the atomic moment is a function of the concentration.—M. **de Broglie** and A. **Lepape**: The K absorption discontinuity of krypton and xenon. Krypton gave $N=36$ ($\lambda = 0\cdot 8648$Å) and xenon $N=54$ ($\lambda = 0\cdot 3588$Å). The last figure is approximate only.—L. **Bull**: A photographic technique for detecting minute deformations in rectilinear objects.—Adolphe **Lepape**: The quantitative measurement of radium emanation by the α-radiation. Corrections due to pressure and to the nature of the gaseous mixture. Corrections, generally neglected, should be applied to measurements of radium emanation: their importance depends not only on the variations of density and composition of the gas present in the condenser, but also on the dimensions of the latter.—Jean **Barbaudy**: The removal of toluene by steam.—A. **Boutaric** and Mlle. Y. **Nabot**: The influence of a third substance on the miscibility of phenol and water.—Marcus **Brutzkuo**: A contribution to the theory of internal combustion motors. Some theoretical considerations of the combustion of gases and liquids in engine cylinders derived from the application of the law of mass action.—Henri **Guinot**: A continuous method of dehydrating alcohol and certain organic liquids. A modification of the Young method for dehydrating alcohol, in which the benzene proposed by Young is replaced by trichlorethylene. The distillate separates into two layers, the lower layer containing only 2 per cent. of water and practically the whole (99 per cent.) of the trichlorethylene. This is returned to the still.—P. **Brenans** and C. **Prost**: The iodosalicylic acids. The 1 . 2 . 3 and 1 . 2 . 5 mono-iodide acids have been prepared, starting with aminosalicylic acids of known constitution: each of these has been transformed into the same 1 . 2 . 3 . 5 di-iodosalicylic acid.—A. **Blanchetière**: The action of dry heat on the alkaline earth salts of the carbamine acids.—L. **Cayeux**: The rôle of the crinoids in the history of the secondary oolitic iron minerals. The contribution of the remains of crinoids to the constitution of the oolitic iron minerals of the secondary epoch is of great importance.—Pierre **Bonnet**: The Neocretacian of Daralagœz (southern Transcaucasia).—P. H. **Fritel**: Two species of ferns new to the fossil flora of the millstone grit of Beauce (Aquitanian).—M. **Gruvel**: Some coral deposits on the western coast of Morocco.—L. **Éblé**: Magnetic measurements in the Paris basin. The values of the magnetic elements calculated to January 1, 1922, are given for 40 stations, ten of which are new.—R. de Montessus **de Ballore**: The methodical prediction of the weather. The results of a study of statistics given by Louis Besson in 1905.—J. **Rivière**: The variation of nocturnal temperature with a clear sky.—G. **Reboul**: The acoustic opacity of banks of clouds: application to the rapid determination of the thickness of a cloud layer.—Maurice **Lenoir**: The nucleolar material during the telophase of somatic kinesis in the nucleus in *Fritillaria imperialis*.—J. **Athanasiu**: Motor nerve vibrations in the animal series.—E. **Wollman** and M. **Vagliano**: The action of light on growth. A description of three sets of experiments on rats: the diet of the first set contained 5 per cent. of butter, and of the second and third sets 1 per cent. of butter. The rats were kept in the dark, but the third set were exposed to ultra-violet light from a mercury vapour lamp for 3 to 5 minutes each day. Other experiments were carried out in which the rats received only 1 per cent. of butter but were exposed to light. The growth of rats receiving only 1 per cent. of butter and exposed to daylight or to ultra-violet light was as rapid as those receiving the larger amount of butter and kept in the dark. If the food contained no butter, irradiation by the mercury lamp had no effect. Light alone cannot compensate for the absence of the fat soluble factor of growth.—Georges **Mouriquand** and Paul **Michel**: Some osteodystrophic factors and their action according to the species of animal. Dietic experiments, with deficiency of the C-vitamin, on rats and guinea-pigs show that these animals present marked differences in bone nutrition under the same conditions of food. The experiments will be extended to other species of animals, and it is pointed out that it is necessary to apply the results of feeding experiments with animals with much care, especially as regards man.—P. **Gillot**: The variations of some carbohydrate reserves in *Mercurialis perennis*. Maltose, which is always present in the reserve organs of this plant, undergoes variations comparable with those of the starch and saccharose: hence this sugar may be looked upon as a reserve substance of the same order as the other polysaccharides.—Georges **Tanret**: Some bases, of the type of tropacocaine, derived from pseudopelletierine.—E. **Kayser**: —The action of yeast on calcium lactate; the production of ethyl alcohol.—Alphonse **Labbé**: The critical zones of adaptation to the medium.—L. **Berland**: The origin of the spiders of New Caledonia. Of 150 species of spiders found, 93 species are confined to that island. The species are most probably of Malay origin in the Oligocene period.—René **Jeannel**: The evolution of the blind Coleoptera and the stocking of the caves in the mountains of Bihor in Transylvania.—Eugène **Lacroix**: The fundamental chitinous texture of the shell of certain Foraminifera. —Armand **Dehorne**: The interstitial cells in the testicle of annelids, Stylaria, and Lumbricus.—Maxime **Ménard** and **Saidman**: The action of the ultra-violet rays on superficial wounds. Details of 17 cases submitted to this treatment, of which 12 were cured and 3 improved.

SYDNEY.

Royal Society of New South Wales, May 2.—Mr. C. A. Sussmilch, president, in the chair.—C. A. **Sussmilch**: Presidential address. No volcanoes either active or dormant occur now in New South Wales, but there is abundant geological evidence to show that at many stages in its past history numerous large active volcanoes existed. Each subdivision of the Palæozoic era had its active volcanoes; during the Ordovician period submarine eruptions took place in the central part of the State. Later, volcanic activity appears to have been confined to the New England area, but here it occurred on a grand scale. A chain of active volcanoes extended from Port Stephens past Maitland, Musclebrook, and Scone, and from thence northwards to Currabubula, and active volcanoes occurred at Gloucester and on the Drake Goldfield. The lavas and tuffs poured out from these volcanoes aggregated many thousands of feet in thickness. In the succeeding Permo-Carboniferous period, when the great coalfields were being laid down, volcanic activity, while less intensive, was still present. In the Mesozoic era, the volcanic forces appear to have died out, and for several millions of years volcanic activity was unknown. In the succeeding Cainozoic era volcanic activity again asserted itself, and twice at least floods of basaltic lavas were poured out, submerging vast tracts of land, and completely covering up some of the then river valleys, thus preserving some of the deep leads afterwards worked for gold, tin, and gemstones. Towards the end of this era, a number of isolated groups of volcanic cones developed; these were the last eruptions to occur in New South Wales, and for the past million or so years volcanic activity has been entirely absent.

Official Publications Received.

Department of Commerce: Scientific Papers of the Bureau of Standards. No. 469: Directive Radio Transmission on a Wave Length of Ten Metres. By Francis W. Dunmore and Francis H. Engel. Pp. 16. 10 cents. No. 473: A Method for the Measurement of Sound Intensity. By J. C. Karcher. Pp. 105-111. 5 cents. (Washington: Government Printing Office.)

The Botanical Society and Exchange Club of the British Isles. Vol. 6, Part 5: Report for 1922. By the Secretary, G. Claridge Druce. Pp. 589-821. (Arbroath: T. Buncle and Co.) 10*s*.

Rhodesia Museum, Bulawayo. Twenty-first Annual Report, 1922. Pp. 18. (Bulawayo.)

The Royal Society for the Protection of Birds. Thirty-second Annual Report, January 1 to December 31, 1922; with Proceedings of Annual Meeting, 1923. Pp. 80. (London: 82 Victoria Street.)

Bergens Museum. Aarsberetning, 1921–1922. Pp. 103. (Bergen.)

Bergens Museum Aarbok, 1920–1921. 2 Hefte. Naturvidenskabelig Række. Pp. 96+71. (Bergen.)

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 45: Status of Certain Social Studies in High Schools. By Harry H. Moore. Pp. 21. 5 cents. Bulletin, 1923, No. 12: Secondary Education in 1921 and 1922. By W. S. Deffenbaugh. Pp. 30. 5 cents. (Washington: Government Printing Office.)

State of Illinois Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 14, Art. 3: A Study of the Malarial Mosquitoes of Southern Illinois. By Stewart W. Chandler. 2: Operations of 1920. Pp. 23-32. Vol. 14, Art. 4: Changes in the Bottom and Shore Fauna of the Middle Illinois River and its Connecting Lakes since 1913–1915 as a Result of the Increase, Southward, of Sewage Pollution. By Robert E. Richardson. Pp. 33-75. Vol. 14, Art. 5: The Helminthosporium Foot-rot of Wheat, with Observations on the Morphology of Helminthosporium and on the Occurrence of Saltation in the Genus. By F. L. Stevens. Pp. iv+77-186+25 graphs+plates 7-34. Vol. 14, Art. 6: The Numbers and Local Distribution in Summer of Illinois Land Birds of the Open Country. By Stephen A. Forbes and Alfred O. Gross. Pp. 187-218+plates 35-68. Vol. 14, Art. 7: Coddling-Moth Investigations of the State Entomologist's Office, 1915, 1916, 1917. By Pressley A. Glenn. Pp. iv+219-289. (Urbana: Department of Registration and Education.)

Department of the Interior: United States Geological Survey. Bulletin 729: Oil Shale of the Rocky Mountain Region. By Dean E. Winchester. Pp. 204+18 plates. Bulletin 734: Deposits of Manganese Ore in the Batesville District, Arkansas, by Hugh D. Miser; with a Chapter on the Mining and Preparation of the Ores, by W. R. Crane. Pp. xi+273+17 plates. 45 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 504: Surface Water Supply of the United States, 1919–1920. Part 4: St. Lawrence River Basin. Pp. iv+188. (Washington: Government Printing Office.) 20 cents.

Department of the Interior: United States Geological Survey. Professional Paper 131-F: Revision of the Flora of the Green River Formation, with Descriptions of New Species. By F. H. Knowlton. Pp. 133-182 +plates 36-40. Professional Paper 131-G: Fossil Plants from the Tertiary Lake Beds of South-Central Colorado. By F. H. Knowlton. Pp. 183-197 +plates 41-44. Professional Paper 131-H: The Fauna of the So-called Dakota Formation of Northern Central Colorado and its Equivalent in South-Eastern Wyoming. By John B. Reeside, Jr. Pp. 199-212+plates 45-50. (Washington: Government Printing Office.)

Queensland Geographical Journal (New Series). Vols. 36-37. Including the Proceedings of the Royal Geographical Society of Australasia, Queensland. 36th-37th Sessions, 1920–1922. Pp. iv+128. (Brisbane: Royal Geographical Society.)

Diary of Societies.

MONDAY, JULY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—M. Ginsberg: The Category of Purpose in Social Science.

FARADAY SOCIETY (at Chemical Society), at 8.—A. Ferguson: A Relation between Surface Tension and Density.—J. Grant and Prof. J. R. Partington: Concentration Cells in Methyl Alcohol.—U. R. Evans: The Law of Definite Proportions in the Light of Modern Research.—J. B. Firth: Determination of the Density of Charcoal by Displacement of Liquids.—F. G. Tryhorn and S. C. Blacktin: The Formation of Anomalous Liesegang Bands.