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CONTENTS.

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Education and Science in the Civil Service Estimates.

THE provision for Education, Science, and Art for the year ending March 31, 1924, in the Civil Service Estimates continues to show reductions upon previous years. Excluding Ireland, the expenditure under these heads was 61,675,301*l.* in 1921–22 and 54,150,207*l.* in 1922–23. For 1923–24 the estimate is 49,902,435*l.*—a sum which is less than the actual expenditure of 1921–22 by 11,772,866*l.* This is an enormous reduction, and however serious the economic situation—and one must grant that the financial stringency is still great—such a reduction cannot be viewed with unconcern by those who have the real interest of the country at heart.

It should be noted, however, that the estimates under review include expenditure other than that upon school education. They include the cost of national museums and art galleries, as well as grants to scientific and industrial research, and to universities and institutions of university rank. The Board of Education estimate is 41,934,047*l.*, a decrease of 3,340,953*l.*; while the estimate of the Scottish Education Department is 5,922,995*l.*, a decrease of 869,379*l.* These two reductions together make up the major portion of the proposed reduction of 4,247,772*l.* for the current financial year.

It will be instructive to examine in more detail some of the proposed expenditure. In the Board of Education estimates the grant for elementary education is put down at 33,069,100*l.*, a reduction on last year of 1,999,693*l.* and on 1921–22 of 3,929,613*l.* One is moved to remark that if a reduction in this grant of almost four millions in two years can be made without detriment to the future efficiency of the nation, there must have been something radically unsound in the distribution of these grants in the past. If, however, the future efficiency is seriously threatened by such a reduction, then an apparent economy may well turn out to be a real extravagance. Again, the estimate for the grant for higher education is 7,315,520*l.*, which means a reduction of 707,055*l.* on last year's grant, or of 1,462,910*l.* on that for 1921–22. It is clear that the reductions in the grants for higher education are proportionately much greater than for elementary education and may well have serious consequences. In particular, it would be difficult to justify the reduction of 4000*l.* for technical colleges—and this in addition to a reduction of 10,000*l.* in the previous year—and that of 123,725*l.* for the training of teachers. On the other hand, it was to be expected that the grant for the higher education of ex-Service officers and men should automatically decrease. Accordingly, 310,000*l.* is estimated as compared with 1,015,000*l.* last year, with a corre-

sponding reduction of 7283*l.* in cost of administration of this grant.

So far as the administrative staff of the Board of Education is concerned, there seems to be little reduction in numbers. Apparently the reduction in the cost of this service will depend mainly upon the fall in the index figure of the cost of living, since the bonuses on salaries are made with reference to it. One would think that in view of the extensive reductions in the grants to elementary and higher education, the estimate of 356,982*l.* for inspection and examination, notwithstanding a reduction of 26,061*l.*, is higher than necessary, and could be further reduced without serious detriment. With one important exception, reductions have been the rule rather than the exception; the estimate for pensions to teachers is 2,400,000*l.*, as against 1,860,000*l.* last year. This increase of 540,000*l.* was expected, and no doubt will be exceeded next year. With regard to this, of course, one must take into consideration the contribution of 5 per cent. of the teachers' salaries.

Under the head of Aid to Students, further reductions are noticeable. Last year there was a reduction of 4500*l.* in the sum allowed for scholarships, studentships, and exhibitions tenable at universities; this year there is a further reduction of 2000*l.* Similarly for students at training colleges the total estimate for this year is 119,170*l.*, as compared with 137,095*l.* last year. The total reduction in the grant in aid of students is 19,982*l.*, and this comes as a further reduction upon a drop of 10,213*l.* last year. One cannot but feel uneasy at the withdrawal of 30,195*l.* in two years from a class of students, presumably deserving, but unable to afford the cost of a higher education.

The estimates contain some interesting "Notes" as to the further measures proposed for keeping down the cost of education. The Board of Education defines its attitude regarding the expenditure of local education authorities which will be recognised for purposes of grant. In 1922–23 this expenditure was not to exceed 62,450,000*l.* A later revision fixed the sum at 60,595,000*l.* This year the amount is limited to 58,902,000*l.*, and of this total not more than 300,000*l.* may be spent on the provision of meals. Higher education fares no better. The total expenditure by the local education authorities to be recognised by the Board of Education for 1923–24 must not exceed 12,160,000*l.*, as compared with 13,000,000*l.* in 1922–23. This year, too, a clause is inserted in the Notes to the effect that the number of students recognised for grant under the Regulations for the Training of Teachers during the financial year 1923–24 is expected to be 12,066, as compared with 12,640 in 1922–23. This reduction, it may be stated, is not due to a lack of candidates coming forward, but to the policy adopted by the Board of reducing the number of those in training.

Turning now to the votes under the Treasury, we find that there are still further reductions. After the reduction of 19,157*l.* last year in the grant for scientific investigation, it is a little disquieting to find a further decrease of 1303*l.* this year. Similarly, the drastic reduction of 118,486*l.* last year in the vote for scientific and industrial research has been followed this year by the proposal of a further net reduction of 20,574*l.* It will be unfortunate if this reduction should hinder the progress of scientific research at a time when such research is most urgently needed. The grant in aid of universities and colleges is estimated at 1,169,000*l.*, which is the same as last year. It will be remembered that in 1921–22 the grant from the Exchequer for the university institutions of the United Kingdom was 1,500,000*l.* Although the present estimate is only for university institutions in Great Britain, the reduction for these bodies this year will be little short of 250,000*l.* At the same time it should be noted that other institutions (in particular, Oxford and Cambridge) and certain clinical units of the London Medical Schools have been since added to the list, and are now receiving substantial grants under this vote. It would seem that universities and colleges as a whole have been badly hit by the economies of the last two years. One can readily understand why those who believe in education, and particularly in higher education, are viewing with grave concern the present position. It would be little short of a national calamity if the opportunities for research or the development of university education in this country were to be restricted at the very time when they should be fostered and encouraged.

Weights and Measures, with some Geophysics.

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. In 5 volumes. Vol. 3: Meteorology, Metrology, and Measuring Apparatus. Pp. vii+839. (London: Macmillan and Co., Ltd., 1923.) 63*s.* net.

IT would be difficult to over-estimate the value of the contents of this book, and our debt of gratitude to Sir Richard Glazebrook for having collected and edited the articles is very great indeed. A certain amount of the information contained is new, and practically the whole of the remainder is inaccessible to the ordinary student.

It is not easy to specify in a few words the subjects treated, and the sub-title—meteorology, metrology,

and measuring apparatus—is not very helpful; in fact, it is difficult to understand why this title was chosen, except for its attractive alliteration, for it certainly would not lead us to expect articles on earthquakes, oceanography, radiation, and many other subjects which are not meteorology, or metrology, or measuring apparatus.

As a matter of fact, most of the subjects treated appear to fall into some such classification as the following:

Measurement.—Theory and practice of measurements of length, mass, time, and their derivatives; alcoholometry; saccharometry; drawing instruments; calculating instruments; combination of observations; and allied subjects.

Geophysics.—Form and mass of the earth; meteorology, including atmospheric electricity; oceanography; seismology and tides.

On the other hand, terrestrial magnetism, electrical and magnetic measurements, and thermometry are not treated in this volume.

One of the chief values of the articles lies in the fact that they are not compilations from text-books and scientific journals, but each is written by a man whose life is engaged on the work he describes. This is clearly seen from the following list of the institutions which have provided writers from their staffs, past or present. There are 43 main articles in the volume, of which 12 are provided by the National Physical Laboratory, 7 by the Meteorological Office, 2 each by the Royal Geographical Society and the Survey of India, 1 each by the Bureau of Standards, U.S.A., and the Ordnance Survey. The writers of the 18 remaining articles include such well-known names as Profs. Boys, Knott, Sampson, Skinner, and Turner; Sir Horace Darwin, and Mr. C. T. R. Wilson.

Before dealing with the articles themselves, it may be worth while to remark on a few points connected with the general arrangement of the book which have struck us very forcibly while reading the 800 or so pages of which it consists. The arrangement is obviously a compromise, and a compromise can never give entire satisfaction. It would appear that the first idea of the work was that of a dictionary with probably the alphabetic arrangement throughout, as in the "Encyclopædia Britannica." But that idea has been modified, and a series of volumes each dealing with more or less allied subjects has been adopted. We cannot be too grateful for this decision; for in these hard times a single volume may be within the means of many who could not afford the whole set. We cannot help regretting, however, that the whole dictionary idea was not abandoned at the same time. Whatever the intention may have been, the volume before us is practically a collection of 43 articles and an index to them; but instead of the latter being placed at the end, it is embodied by the dictionary method throughout the whole book, and the articles are strung on to it like large beads on a necklace. This method has two great drawbacks: in the first place, the long breaks in the sequence of the words, due to the interpolation of the long articles, make it difficult to turn up a word quickly. Then technical difficulties of printing have made it impossible to give references to pages, and the reader is referred to sections and paragraphs of the main articles, the title of the article being set out in full in each case. This entails a great deal of unnecessary printing, and it is not easy to find a specified paragraph, as the sections in some cases extend over several pages. A simple index with references to pages would have served the same purpose, and would not only have been easier to use but also probably have reduced the size of the volume by many pages, with great convenience to the reader and a reduction in the cost of printing.

While we are discussing the convenience of the reader, it may be as well to direct attention to the want of system with regard to references to literature. Some of the articles have very full references while others have practically none, but the method of making the references varies from article to article. In some the references are given in the text, in others in footnotes, while in a few they are collected together in a bibliography at the end of the article, the numbered items of which are indicated in the text by the use of numbers in brackets. In fact, this book reflects the chaos in general scientific literature in this matter. Nothing is more disturbing when reading a difficult article than to have the attention constantly distracted by frequent references to footnotes, some of which may be of importance to the argument, and therefore must be read, while others are only references to literature. For this reason it is surely desirable that there should be some distinction between the two kinds of references. The method which seems the most reasonable is to use figures in brackets in the text to connect with references to literature collected together at the end of the article—or chapter in the case of a text-book—while notes necessary to the argument should be given, if they cannot be avoided, at the foot of the page, and attention directed to them by an asterisk or other conventional sign used to indicate a footnote. In this way a reader would almost unconsciously pass over the literature references and yet never miss a footnote. The advantages of this method are so obvious when many references are given that it is surprising it is so little used.

There is still one more point of arrangement which

affects the convenience of the reader. The articles in these volumes owe their outstanding value to the high authority of the authors, and it is unlikely that any one will consult an article without wishing to know who wrote it. He will look first at the beginning of the article, and not finding the name there he will probably turn to the end, where he will find the initials of the author. But it is very seldom that the initials of the best-known writers are familiar, so the reader has not yet got the information he requires. He may then recollect having seen a "List of Contributors" at the beginning of the book, and here he will finally find the name belonging to the initials. Why should not the name of the writer have been put at the commencement of each article, where the reader naturally turns to find it?

Returning now to the articles themselves, they are so numerous, and deal with so many subjects, that it is quite impossible to notice them all, so we must content ourselves with a few words on one or two of the most important.

In the group of articles dealing with measurement, the discussion of metrology by Mr. J. E. Sears, the Deputy Warden of the Standards, is of outstanding merit. Without going into a great deal of detail a clear account is given of the history of the British and metric standards of length, mass, and volume, followed by the theory of the methods used in comparing these standards with practical measuring apparatus. It will come as a surprise to most people to read in this article that two kilogram masses can be compared with a greater accuracy than two metre standards, the accuracy being one part in 10^8 and in 10^7 respectively. Mr. Sears's discussion of the relative advantages of the British and metric systems is very valuable, and clearly indicates that the advantages are not all on one side. He is strongly opposed to attempts to hurry a change in Great Britain, and concludes: "The only practical policy, and that which has actually been followed, is to give legal sanction to the *alternative* use of the metric system, and to trust to the processes of time to effect a gradual change. The efforts of those who desire to see the metric system in universal use would be more usefully employed in endeavouring to encourage and facilitate its voluntary adoption in this way, than in seeking to secure legal compulsion in advance of public desire."

This article on metrology is supplemented by separate articles dealing with the practical side of making measurements and comparing standards. These are nearly all written by members of the staff of the National Physical Laboratory, hence we have in them extremely valuable information of the actual methods used in this country. It is true that when reading the articles one misses information on some point or other which would have been useful, but everything cannot be included in a book of finite dimensions, and on the whole the choice of subjects is good. The only criticism one has to make in this respect, and it applies to the book in general, is that the articles are very uneven in the amount of detail given. There can be no doubt that "gauges" are an important accessory in all accurate measurements of length, but are they so important as to justify the longest article in the volume and more than fifty per cent. more space than is given to the article on metrology itself? One cannot help feeling that in this article we are taken outside applied physics into engineering practice.

The chief article on the measurement of time is one by Prof. Sampson on clocks and time-keeping. It is a delightful article to read, for while it is short and not overburdened with detail, there is no difficulty in grasping the principles employed in the different forms of clocks described. After reading these thirty pages, one has the feeling (it may not be justified) that one knows all there is to know about clocks and their ways from the Glastonbury Abbey clock of 1325 to the latest Riefler.

In the geophysical section we cannot help regretting that more space has not been allotted to the writers, even, if necessary, at the expense of the articles dealing with measurements, which in some cases, as already mentioned, are overburdened with detail. Some of the articles are so abbreviated as to lose a great deal of their usefulness; this is particularly the case with the article on meteorological optics, which consists of only sixteen pages, while the descriptions of thirty-two different map projections are compressed into five pages.

The articles by Sir Napier Shaw and Capt. Brunt indicate very clearly the great changes which have taken place during the present generation in the outlook of meteorologists. Meteorology has changed from being an observational study of weather and its changes to a study, largely deductive and mainly mathematical, of the atmosphere as a whole. It is not surprising, therefore, that one hears occasional complaints that the modern meteorologist is too fond of theory and long names. On the other hand, the recording of weather had gone on for many, many years without much progress in our knowledge of the "way of the air"; but in recent years the physicist and mathematician have looked our way and the progress has been startling. In this advance two names stand out pre-eminent in this country, Dines and Shaw, and both have written articles for this volume. Sir Napier Shaw's article on "The Thermo-

dynamics of the Atmosphere" is characteristic, and therefore full of new ideas and new views of old ideas. He treats the atmosphere as a whole as a "heat engine" of the classical type. An indicator diagram of a novel type, in that the co-ordinates are temperature and entropy, is constructed, and we are taken through a "cycle of operations" which involves a return ticket from Java to "the cold slopes of the mountainous Arctic and Antarctic lands," and during the course of which we realise our entropy like a normal traveller cashes his circular notes, and occasionally we receive fresh funds from the water vapour which we have smuggled in our luggage. Sir Napier also introduces us to the "resilience of the atmosphere," from which "arises the capacity of a layer of air to act as a 'deck' or ceiling, preventing any vertical motion, and therefore limiting the motion of the atmosphere to horizontal layers." The whole article is stimulating and its value cannot be overrated.

Those of us who are interested in atmospheric electricity are feeling more and more the need for a good account in English of this branch of meteorological physics. There is more than enough material for a good-sized book, but the few workers in atmospheric electricity in this country have other interests, and there appears to be no immediate prospect of the need being satisfied. We have all the more reason, therefore, to be grateful to Mr. C. T. R. Wilson—one of the qualified workers who has other interests—for his article. There are so many unsolved problems in atmospheric electricity that any account of the work done and of the theories propounded to explain the observations must of necessity exhibit the personal opinion of the writer. This article is no exception, and Mr. Wilson's point of view is clearly discernible. His account is, however, perfectly fair, and as unbiassed as it could be in the circumstances.

Most writers have recently acknowledged themselves defeated in their attempts to explain the maintenance of the earth's normal electrical field, but Mr. Wilson makes it quite clear that in his opinion thunderstorms offer a way of escape from this impasse. The small amount of evidence which he adduces is not very impressive, but until more work has been carried out along the lines indicated by Mr. Wilson it will not be possible to say that his solution is incorrect.

We began this review with expressing gratitude to Sir Richard Glazebrook, and we cannot do better than end on the same note. The criticisms we have made are of secondary importance and are very much in the nature of looking a gift horse in the mouth. But there is no objection in examining the mouth if it helps one to understand the gift and to make the best use of it.

G. C. SIMPSON.

Climatic Changes.

(1) *The Evolution of Climate.* By C. E. P. Brooks. Pp. 173. (London: Benn Bros., Ltd., 1922.) 8*s.* 6*d.* net.

(2) *Climatic Changes: their Nature and Causes.* By Ellsworth Huntington and S. S. Visher. Pp. xvi+329. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 17*s.* 6*d.* net.

"A HUNDRED million or a thousand million years ago the temperature of the earth's surface was very much the same as now," say Profs. Huntington and Visher in the first chapter of their "Climatic Changes" (p. 15). This uniformity of climate throughout geological time, in contrast with the inconstancy of the weather from day to day and from year to year, is the great paradox of geological meteorology. The climatic conservatism of the earth as a whole is qualified by great local changes which have produced glaciations at about ten different geological dates and acclimatised in high latitudes plants allied to those now confined to warmer regions. The study of climatic changes has the especial attraction that it is a tempting explanation of the fall of civilisations and States, since man is obviously dependent on the weather.

(1) The perennial controversy as to whether climatic change is due to terrestrial or to celestial causes is continued in the two new works by Brooks and by Huntington and Visher. While Mr. Brooks maintains that the climatic changes proved by geology can be explained by alteration in the distribution of land and water, the American authors attribute them to occasional changes in the condition of the sun. Mr. Brooks in expounding, his conclusion, rejects the atmospheric theories based on variations in the amounts of carbon dioxide and of volcanic dust, and his verdict on this question is given added weight by Dr. G. C. Simpson's testimony, in an introductory note, to his authority on meteorology. Mr. Brooks explains the last main geological change of climate as due to great uplifts of land in high latitudes having enlarged both polar glaciers and tropical deserts. He "shows how enormously effective the land and sea distribution really is," by calculating what the temperatures on one zone on the earth would be if it were composed solely of land or were occupied entirely by sea. In a useful appendix he provides data by which the effects on temperature of variations in land and sea can be calculated.

Unfortunately, the meteorological sections of Mr. Brooks's work are relatively short, and most of it is devoted to accounts of geological and historical variations of climate on which the author's opinions are less

authoritative. He adopts the views of Prof. Ellsworth Huntington that some great political changes in classical times were due to a climatic change in the southern part of the North Temperate zone. These views were discussed and rejected in a paper in the *Geographical Journal* (vol. 43, 1914, pp. 148–172, 293–318), and as Huntington and Visher, who quote that paper, say (p. 92) that in the main its "conclusions seem to be well grounded," the former author has apparently abandoned some of the views which Mr. Brooks still quotes on his authority. That section of Mr. Brooks's work is out of date, as is also the argument based upon the occurrence of Galaxias in South America and New Zealand, since the discovery that this fish breeds in the sea. The main value of Mr. Brooks's book depends on its meteorological chapters and its weighty support to the conclusion that glaciations can be explained by geographical changes. He omits reference to the impressive testimony on behalf of that theory by Lord Kelvin.

(2) The interesting and suggestive volume by Messrs. Ellsworth Huntington and Visher shows an exceptional knowledge of the literature and contains an illuminating discussion of important problems on the borderland of meteorology, astronomy, and geology. They discuss Brooks's paper in support of the geographical explanation of glaciations, but dismiss it, since the distribution of ocean and continent at the time of the Pleistocene glaciation was much the same as it is now; the differences they claim were insufficient to have produced so great a climatic change. They admit that changes in the positions of land and sea may be an important secondary agency. Differences of opinion as to past climates are not surprising in face of the authors' divergencies of statement as to existing geography: "To-day the loftiest range in the world, the Himalayas, is almost unglaciated" (Huntington and Visher, p. 144); "The Himalayas, owing to their heavy snowfall derived from the south-west monsoon, bear numerous great glaciers . . ." (Brooks, p. 77).

The authors adopt the view that climatic changes are due to variations in solar activity. They have been convinced, in spite of a prepossession to the contrary, that the periodicity and seasonal variation in earthquake action and concurrent climatic changes are due to a planetary influence which also controls the appearance of sun-spots. They discuss the nature of this influence and conclude that it is not tidal but electrical. The effect on the earth of increased sun-spots is not by direct variation in temperature, since increased glaciation does not involve any general change in the earth's temperature, which the authors insist has been practically uniform throughout geological time. Increased solar activity affects the earth by producing special storminess, with increased snow-fall in areas of high pressure and diminished rainfall and loess formation elsewhere. If the planets have such an important though indirect effect upon the earth's climate, the approach to the solar system of some of the greater stars must from time to time have a still more powerful influence on solar activity. The authors claim that great stars may approach the solar system sufficiently to stimulate intense activity in the sun, and thus produce glaciations on the earth at intervals of time consistent with the requirements of the geological history of climate.

The views on geological climates put forward by Messrs. Huntington and Visher appear to be generally well substantiated, as in their belief in the existence of climatic zones throughout geological time (p. 171) and that (p. 169) "as far back as we can go in the study of plants, there are evidences of seasons and of relatively cool climates in high latitudes"; but their conclusions as to historic variations in climate are less well supported. They attribute the English famines of 1315–16 and 1321 to a special climatic stress due to a "considerable swing towards the conditions" that produce glaciations. In support of this view they quote Petterson (Quart. Jour. Meteor. Soc., vol. 38, 1912), that the 14th century was a period of extreme climatic variation, but they have overlooked Hildebrandsson's reply to Petterson's paper (Nov. Act. R. Soc. Sci., Uppsala (4), IV., 1915).

Famines are so often due to an untoward concatenation of many unfavourable circumstances that they are not a sure foundation for hypotheses of climatic change. Standard authorities on the historical distribution of famine do not support the view that the English famines in the early part of the 14th century were abnormal in origin. It is even doubtful whether that period was especially famine-stricken. Dr. Farr, in his classical paper on the variation of wheat prices (Journ. Statist. Soc., London, IX., 1846, pp. 158-174), shows that famines were evenly distributed throughout the 11th to 16th centuries. "In the 11th and 12th centuries a famine is recorded every 14 years on an average, and the people suffered 20 years of famine in 200 years. In the 13th century my list exhibits the same proportion of famine, and nearly the same number of years of famine. . . . Upon the whole, the scarcities decrease during the three following centuries; but the average from 1201 to 1600 is the same—namely, 7 famines, and 10 years of famine to a century. This is the law regulating scarcities in England." Walford's table of famines (Insurance Cyclopædia, 1874, vol. 3, pp. 165–170) shows that the rise in the price of wheat during the famine of 1315–16

was exceeded in that of 1437–38, when the rise of price from 4*s.* or 4*s.* 6d. a quarter to 26*s.* 8*d.* was higher than the quintuple increase upon which Huntington and Visher lay stress for 1315.

The English scarcity from 1581–1603 was equally far-reaching, as famine at the same time caused cannibalism in Ireland and devastated Persia. The famine in England from 1694–99, attributed also to "rains, frosts, snows—all bad weather," might have produced as disastrous consequences as that in the 14th century, but for the improvement in internal transport. An instructive table in Brooks's volume (p. 155) discredits the hypothesis that the English famine of 1315–16 was due to a period of abnormally severe weather, as it represents severe winters as fairly evenly distributed throughout the half centuries from 1075 to 1425. The discussion of the causes of these famines by Thorold Rogers ("Agric. and Prices in England," vol. i., 1259–1400, 1866, pp. 28–30), whom Huntington and Visher quote for facts about the 1315–16 famine, gives no support to the view that they were due to any progressive change in climate or to climatic severity of a special order. J. W. GREGORY.

The Copper Age in Spain and Portugal.

La Civilisation énéolithique dans la Péninsule Ibérique. (Arbeten utgifna med understöd af Vilhelm Ekmans Universitetsfond, Uppsala, 25). By Nils Åberg. Pp. xiv+204+25 plates. (Uppsala: A.-B. Akad. Bokhandeln; Leipzig: Otto Harrassowitz; Paris: Libr. Honoré Champion, 1921.) 15 Kr.

IT is a pleasure to peruse the work of an author like Dr. Nils Åberg, whose studies are so comprehensive. Too many prehistorians work and publish in their own small area without much reference to cultures outside, or occupy themselves with the necessary, though in the long run barren, task of extracting the more important essentials from the ever-growing mass of literature in order to present a concise scheme that can be used by others as a basis of study. Dr. Åberg's objective is far wider in scope, for although his main interest is naturally in Scandinavia, the whole of Europe is really included for the purposes of his work. The volume in front of us is only the latest of a number of memoirs, the object of which is to trace, from a study of the typology of various objects, the directions from which came the influences that were at work in Europe from Neolithic to Bronze Age times.

Any prehistorian who has worked on the Continent will derive pleasure from the very first page, for the book is dedicated to Émile Cartailhac. To those who have worked with and drawn inspiration from Cartailhac such a dedication seems natural. But here it is not only a tribute to that wonderful old man, who died in harness only a short while ago, for his book, "Les Ages préhistoriques de l'Espagne et du Portugal," published so far back as 1886, still remains a standard work on early times in the Iberian Peninsula, and again and again the reader will notice the use that Dr. Åberg has made of it.

A great deal of work has been done by Dr. Åberg, and a number of collections, both private and in museums (not to speak of the considerable literature on the subject), has been utilised in the compilation of this work. The book opens with a short preface in which the author exposes his reasons for studying the area and his general views. There follows an introduction in which the current views and the literature of the subject are shortly discussed. Next, after giving an account of the background to the period under discussion, the development of the megalithic tombs in the Peninsula, and the principal objects and types of tool found during the Iberian copper age, are described and illustrated by numerous and excellent figures and plates. The whole forms an exceedingly useful study which can only be gathered elsewhere by a process of foraging in much larger works. There follows an account of a number of sites in Portugal and Spain; finally a brief comparative study of similar cultures elsewhere, in France, Italy, and England. Much local work has still to be published by Bonsor and others, and many details still await solution, but in the meantime, the volume before us gives a clear and rapid account of what has been done, and its important bearing on the contemporary cultures farther north. The Spanish Peninsula has been favoured in having large deposits of metal ores, and so a brilliant copper age developed, the influence of which was felt farther north in regions where stone tools still had to be used owing to lack of metal ores, at a time when little commerce was possible.

The book is lacking in one particular respect, and that is in the absence of an account of the Spanish "Third Group" rock-shelter paintings. This art clearly belongs in date to our author's period, for many of the conventionalisations figured on pottery appear on the walls of the rock-shelters. Thus on pages 133 and 145, decorations engraved on pottery from Los Millares and Las Carolinas are illustrated, which can be matched exactly by paintings on the rock-shelter walls (for example, at Jimena, at Las Figuras, and a score of other sites). This art was not purely decorative; it had some (as yet imperfectly known) object, and so is important in tracing out the civilisation of the period. It is true that there has not been as yet any complete or satisfactory study published on this subject, so that its importance has not been always properly realised.

Sufficient has been done, however, in this respect to make its omission from Dr. Åberg's book a serious blemish. This can easily be rectified in a later edition by the addition of a further chapter.

Dr. Åberg is to be congratulated on his excellent work, which indeed well repays a careful perusal.

M. C. BURKITT.

A Railway Manual.

Manuel des chemins de fer. Par J. Bourde. (Bibliothèque Professionnelle.) Pp. 444. (Paris: J.-B. Baillière et fils, 1922.) 12 francs.

M. BOURDE'S book is intended for workers who are desirous of extending their knowledge over larger fields than is covered by their actual every-day work, and for whom the big special volumes are inaccessible or unintelligible. The author is of opinion that the workman is too often condemned to be a mere wheel in a mechanism, and that he is not allowed sufficient initiative. The series of volumes to which our author's book belongs is intended to furnish opportunities for the workman, and each of the 150 volumes has been written by an author who has special knowledge of the subject on which he writes. The reason for the lack of works of this type in this country is probably connected with the difference between the French and English people in their mental characteristics and in their education. The English are of course intensely practical, and not at all bookish. It is not implied that the French are not practical, but they have been brought up more on the bookish side than English engineers. The present writer knows one railway engineer who is—or was—anxious to write a book on railways, and he had accumulated a great mass of material. His lack of literary skill and the immense volume of his own knowledge will, however, in all probability prevent the completion of the book.

The volume under review, dealing with railways from the engineering point of view, covers the ground very thoroughly; it is written in plain language and gives the essentials to such an extent that a person having already a practical acquaintance with any one branch of railway work would, by the aid of the book, readily fit himself to deal with problems outside his own special domain.

With regard to the details of the book, a beginning is made with surveying and levelling, the drawing of plans and representation of heights by contour lines and other methods. With this preliminary the author is in a position to tackle the general design of the railway line, including questions of traffic, gauge of rails, curves, and gradients, all from the most general point of view, and so as to decide on the best route. Other chapters discuss, from the same point of view, transition curves, cuttings and embankments, the calculation of earthwork, the latter subject being treated in considerable detail; also the problem of the economical arrangement of excavation and embankment, considered especially with respect to length of haul.

Assuming now that the actual route is decided upon, the author treats of the detail design and carrying out of the work, this portion of the book taking up more than one half of the whole 444 pages. There are six chapters treating in succession of the design and execution of cuttings and embankments, bridges, viaducts, culverts, and tunnels; then follow two chapters on masonry works with a general discussion of the materials to be used: stone, metal, wood, etc.

With all the earthwork finished, bridges and heavy masonry work completed, the next subject is the permanent way of the line, and the author gives a very clear and concise account of the several component parts, especially dealing with the rail, its different sections and methods of support, with a clear treatment of the gradual introduction of curvature on rails by means of transition curves. The planning of stations, with the various problems involved in the junctions and crossings of the tracks, is given fairly thoroughly, and a chapter is devoted to station buildings, including the buildings required for the rolling stock.

The book is of a type which would be welcome in Great Britain, although of course a translation would be of little use.

Our Bookshelf.

Carl Rümkers Hamburger Sternverzeichnis 1845·0, enthaltend 17724 Sternörter, abgeleitet aus den Beobachtungen am Meridiankreis der Hamburger Sternwarte in den Jahren 1836 bis 1856. Herausgegeben von Dr. Richard Schorr. Pp. xiv+488. (Bergedorf: Verlag der Sternwarte, 1922.) n.p.

DR. RICHARD SCHORR has rendered a great service to exact astronomy in making and publishing this reduction of the great Hamburg catalogue of Carl Rümker, containing 17,724 stars, mostly faint, observed with the Repsold Transit Circle (of 4 inches aperture) between 1836 and 1856. It is of interest to learn from the short biographical sketch of Rümker that he held a commission in the British Mediterranean fleet from 1812 to 1817, holding the post of instructor in navigation. He then went to Paramatta Observatory, N.S.W., as director; while there he made useful observations of Encke's Comet at its first predicted return in 1822. He returned to Hamburg as director of the Observatory in 1833, remaining there till his health failed in 1857. The Transit Circle was quite a good one, and the early date of the stellar observations renders them of value for the determination of proper motion.

The reduction has been repeated *ab initio*, the data being entered from the original observing books. The clock and azimuth errors and equator-points were derived by the use of Auwers's positions of fundamental stars. Pulkovo refractions were used. The probable error of a re-reduced catalogue place (depending on 1·8 observations, the average number) is 0·083^s secant decl. in R.A., and 1·0″ in decl. The difference of magnitude equation for 3·5 mag. and 8 mag. is about 0·08^s. This has not been applied. The star places were compared individually with those of the Astronomische Gesellschaft Catalogues and the differences are given beside the star places, though the interval in years is not given.

Many errata in Rümker's reductions were detected and corrected in the course of this comparison. These are mentioned in footnotes. There were some stars for which Rümker did not read the full number of microscopes, but in all cases there is ample material to determine the necessary correction. Finally a list is given of the proper motions that have been published for Rümker stars, some 6000 in number. It should now be possible to increase this list with the aid of the newly published positions.

To save expense the catalogue was not set up in type, but written by hand and multiplied by a mechanical process. It is, however, quite clear and legible.

A. C. D. C.

Mathematik und Physik: Eine erkenntnistheoretische Untersuchung. Von E. Study. (Sammlung Vieweg, Heft 65.) Pp. 31. (Braunschweig: F. Vieweg und Sohn, 1923.) 675 marks.

IN this tract Prof. Study's chief aim is to discuss the question: What is to be regarded as mathematical and what as specifically physical in theoretical physics? How comes it that parts of mathematics and of physics can be combined so as to form a higher unity? For the purposes of his discussion he defines mathematics as the limit towards which present-day mathematics seems to him to be tending, in which it will include calculation by means of natural numbers (positive integers) with all that is based thereon, and nothing besides. When, for example, projective geometry is "arithmetised" by identifying a point, or a straight line, with the set of homogeneous co-ordinates representing it, the word point, or straight line, as the case may be, becomes merely a symbol bearing no logical relation either to the material world or to our concept of space.

Thus all branches of geometry, Euclidean or other, are logically independent of experience. Similarly "arithmetical physics," arising from the arithmetisation of the mathematical portions of physics, is based logically on calculation by means of numbers alone, developed in one particular direction, chosen from many possible alternatives on the basis of a judgment of value, not of cause, in so far as it is desired to make only investigations closely related to experience. Thus the relation of theoretical physics to the content of experience appears to be not logical, but only psychological and historical. The content of theoretical physics is threefold: (1) a purely mathematical part, characterised by the method of deduction; (2) an experimental part, characterised by the method of (incomplete) induction; and (3) an intermediate part, characterised by an independent method, that of "idealisation." By idealisation Prof. Study means the process whereby we substitute the simple abstract reality of mathematics for the infinitely complex and barely comprehensible reality of physics.

This tract can be recommended as a very stimulating introduction to the philosophical aspects of mathematics and physics by a writer who is eminently fitted for the task by the wide range of his knowledge as well as the importance of his own contributions to science.

Musical Acoustics based on the Pure Third System. By Thorvald Kornerup. Translated by Phyllis A. Petersen. Pp. 56. (Copenhagen and Leipzig: Wilhelm Hansen, 1922.) 2*s.* 6*d.*

IN this little book the author discusses very fully the relations of the pitches of the notes in the various scales in just intonation and in a variety of temperaments. Instead of Ellis's logarithmic cents, the millioctave is here used, which (as its name implies) is one-thousandth of an octave instead of Ellis's one-twelve-hundredth of the octave. It is pointed out early in the work that for a pure intonation of the minor triad, D F A, the D must be only a small tone above C and a large tone below the just E. The fact that the major chord, G B D, equally needs a D which is a small tone below the just E and a large tone above C, does not seem to receive equal emphasis.

The book contains very many diagrams and tables. One of the most striking diagrams is the author's tonal circle in which the circumference contains a single octave, equal *angles* corresponding to equal *differences* of frequencies. Thus, putting one C at the starting-point on the circumference, the other notes occur at the following angles, the D being what is called in England grave D and denoted by D`. The ordinary D would be at 45°.

Angles .	0°	40°	90°	120°	180°	240°	315°	360°
Notes .	C	D`	E	F	G	A	B	C′

Quite a number of scales and temperaments are treated at length, special attention being directed to the nineteen steps to the octave, which is considered to be the consequence of the third system and the practical ideal. Other temperaments considered are as follows, and illustrate the fulness of the treatment:

No. of Tones.	Steps in Tone.	No. of Semi-tones.	Steps in Semi-tone.	Steps in Octave.	Author.	Date.
5	× 2	+ 2	× 1	= 12	Aristoxenos.	c. 350 B.C.
5	× 3	+ 2	× 2	= 19	Elsasz.	c. A.D. 1590.
5	× 5	+ 2	× 3	= 31	Vicentino.	c. 1546.
2 × 6 / 3 × 7		+ 2	× 4	= 41	Paul v. Janko.	1882–1901.
2 × 8 / 3 × 9		+ 2	× 5	= 53	Nicholas Mercator.	c. 1675.

The work is in some respects rather fanciful but will repay careful study. E. H. B.

Production économique de la vapeur. Par Dr. O. Manville. Pp. vii + 407. (Paris: Gaston Doin, 1923.) 25 francs.

M. MANVILLE'S work is timely. While French industries in pre-War days consumed 64 million tons of coal, the addition of Alsace-Lorraine has increased the potential demand to 80 million tons. To meet this there exists

but 25 to 30 million tons from the French mines (compared with 40 millions in the days when the mines had not suffered from war), leaving a possible gap of 55 millions in the balancing of the account. The author, who is obviously alarmed by these figures, estimates the supplies from Belgium, England, the Saar, and Lorraine as but 29 millions and speculates doubtfully on the prospect of getting regularly the required balance from Germany. He points out that in any case the cost of the imports must be in the neighbourhood of 6 milliards of francs, unless the present wasteful methods of coal utilisation are changed. To the elimination of these wasteful methods the author accordingly addresses himself, suggesting that in the matter of steam production alone two of the six milliards can be saved.

The book contains a full and satisfactory account of modern steam plant and its various accessories, besides giving much space to calculations. The author remarks, "La plus grande partie de nos usines ont une origine modeste. Ce sont de petites installations, qui se sont développées, au cours d'affaires plus ou moins heureuses." Those in charge of the modest organisations of which he speaks may find the book rather difficult, but their remedy is simple since the author is a consulting engineer and his personal assistance will doubtless be available on demand.

The Sea Gypsies of Malaya: An Account of the Nomadic Mawken People of the Mergui Archipelago. By W. G. White. Pp. 318. (London: Seeley, Service and Co., Ltd., 1922.) 21*s.* net.

THE Mawken of the Mergui Archipelago, more generally known as the Selung, whose customs, beliefs, and modes of life are described in this volume, are literally nomads of the sea, as the greater part of their life is passed in their peculiarly constructed boats. The reason they themselves give for this mode of existence is, that after they had migrated from the mainland, whence they had been driven by the incursions of Burmese peoples, they had to abandon their settlements on the islands owing to the raids of Malayan pirates. It is a moot question whether they are to be regarded on linguistic grounds as the northernmost branch of the sea-going Malays or as a derivation from Further India. Their own traditions, as already mentioned, favour the latter origin. As the author was in charge of the census of these people in 1911, he was able to obtain a considerable insight into their system of relationship, of which a remarkable feature is the stress laid upon the distinction between elder and younger in most, but not all, the degrees of relationship. It is a pity that Mr. White's work has called him to another part of the world and that he will not be able to carry out further investigations among this interesting and little known people.

The Meaning of Meaning: a Study of the Influence of Language upon Thought and of the Science of Symbolism. By C. K. Ogden and I. A. Richards. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xxxii+544. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1923.) 12*s.* 6*d.* net.

THIS rather pretentious volume is at least twice the size it need have been in consequence of the choice by the editors of uncomfortably large type and extravagant spacing. Its title is apparently adopted from the subject of a symposium at the Oxford philosophical congress of 1921, and the book is a medley of already published papers and editorial paragraphs. The collaborating authors of the main essay apologise in the preface for its lack of systematisation, and make the excuse that their lives are too busy for them to spare the time necessary to re-write it. They have included in their book an introduction by a third author and supplementary essays by a fourth and fifth. The aim of the whole is to provide materials for a science of meaning. The book contains a good deal of amusing matter and some valuable criticisms, but it is formless and unequal.

Chile: To-day and To-morrow. By L. E. Elliott. Pp. x+340+plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1922.) 24*s.* net.

AMONG recent books on Chile this stands out as one of the most important and fullest for purposes of reference, although its value in this respect is somewhat impaired by the lack of an index. The sections on Chilean history and on mining and agriculture are particularly full and useful. The book would be enhanced by more attention to the physical features and climate of the country, which are both treated very briefly. Like most books on South America this volume is mainly eulogistic, but the critical note is not absent, and the author clearly has a wide experience of the country. There is an interesting chapter on Easter Island, the distant possession of Chile in the Pacific.

Elementary Determinants for Electrical Engineers. By H. P. Few. Pp. vi+98. (London: S. Rentell and Co., Ltd.; New York: D. Van Nostrand Co., 1922.) 4*s.* net.

IN many of the everyday calculations of electrical engineering, determinants are useful, and Prof. Fleming showed many years ago how the resistances of networks can be computed by their means. The very complicated formulæ which telephone engineers use in order to balance the capacity effects in multiple twin cable are easily proved by determinants. This book can be very easily understood, and will be appreciated by those for whom it is written. The examples are numerous and well chosen.

Optical Methods in Control and Research Laboratories. By Dr. J. N. Goldsmith, Dr. S. Judd Lewis, and F. Twyman. Vol. 1: Spectrum Analysis, Absorption Spectra, Refractometry, Polarimetry. Second edition. Pp. iv+56+3 plates. (London: Adam Hilger, Ltd., 75A Camden Road, 1923.) 1*s.* 6*d.*

THIS pamphlet forms a valuable introduction to the use of spectroscopes, spectrophotometers, refractometers, and polarimeters, and, while avoiding detailed descriptions of the instruments, gives ample references to such descriptions. Sufficient information is given in the pamphlet to enable a works physicist to select the proper instrument for the work to be done and to know where to look for further information on the subject.

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 Crossed-orbit Model of Helium, its Ionisation Potential, and Lyman Series.

TAKING for granted the dynamical legitimacy of the crossed-orbit model as originally proposed by Bohr (*Zeits. für Physik*, ix., 1922, p. 1) for normal helium, I find for its negatived total energy, with the usual Coulomb law of force, and treating the two orbits as "*circular*" *in the literal sense of the word*,

$$-E = 7N_\infty ch\left[1 - \frac{1}{4\pi}F\left(\sin\frac{i}{2}\right)\right], \quad . \quad . \quad (1)$$

where F is the complete elliptic integral of the first kind, i the inclination of the planes of the two one-quantic orbits, in Bohr's case 120°, and the remaining letters are the usual symbols of the universal constants. In accordance with symmetry, the electrons are assumed simultaneously to pass the nodes, that is, the opposite ends of the common diameter. (Details of deduction of (1) are given in a paper to be published shortly.) If one of the electrons be removed to "infinity," the energy of the remaining ionised atom He^+ is $-4Nch$, where $N = N_\infty : (1 + m/M)$. The small difference $N_\infty - N$ being irrelevant for our purpose, the ionisation work thus becomes, by (1), $W = Nch(3 - 7F/4\pi)$, or, the equivalent wave-number (of the flash emitted at the return of the removed electron),

$$\nu = N\left[3 - \frac{7}{4\pi}F\left(\sin\frac{i}{2}\right)\right]. \quad . \quad . \quad . \quad (2)$$

For Bohr's model $i = 120°$ and, to four decimals, $F = 2{\cdot}1565$. Thus $\nu = 1{\cdot}7987N$, and since N is equivalent to 13·54 volts, the corresponding *ionisation potential*,

$$V = 24{\cdot}35 \text{ volts}, \quad . \quad . \quad . \quad . \quad (3)$$

which is remarkably close to 24·5, the latest value observed and corrected by Lyman. The wave-length corresponding to (3), or the limit of Lyman's new series, would amount to $\lambda_\infty = 506{\cdot}8$ Å.

Thus far Bohr's (idealised) model, corresponding to $-\cos i = \frac{1}{2}$, a value supported in Bohr's paper (*l.c.*, p. 32) only by a terse reference to the quantum condition for atomic angular momentum.

Now, suppose for the moment that there are dynamically possible states of the system also for some inclinations differing from 120°. Then the wave-number emitted at the passage from He^+ to such an i-model will be given by (2), with $N = 1{\cdot}097_3 . 10^5$ as a sufficiently correct compromise value. It has seemed especially interesting to apply (2) to *simple rational values* of $-\cos i$ other than $\frac{1}{2}$, with a particular view of covering, perhaps, some of the observed members of Lyman's series, which are four,

$$\lambda_1 = 584{\cdot}4,\ \lambda_2 = 537{\cdot}1,\ \lambda_3 = 522{\cdot}3,\ \lambda_4 = 515{\cdot}7,$$

with the conjectured λ_∞ corresponding to 24·5 volts or, very nearly, to (3) as limit. The results thus obtained were as follows:

The "normal" value $-\frac{1}{2}$ being already treated, the next simple rational value $\cos i = -\frac{2}{3}$, to which corresponds $F = 2{\cdot}3404$, gave, by (2),

$$\lambda = 537{\cdot}2,$$

encouragingly close to the observed λ_2. The very next, however, $\cos i = -\frac{3}{4}$, yielding $\lambda = 561{\cdot}9$, was, for the present, without interest. Further, $\cos i = -\frac{4}{5}$, with the semi-inclination 71·585° and $F = 2{\cdot}5892$, gave

$$\lambda = 585{\cdot}0,$$

close enough to the observed λ_1, and $\cos i = -\frac{8}{9}$, $i/2 = 63{\cdot}435°$, $F = 2{\cdot}2571$, yielded

$$\lambda = 522{\cdot}9,$$

equally close to λ_3. But one observed member of the series, 515·7, remained uncovered. Working back from this, by (2), the required semi-inclination is found to be 61·97°, whence $-\cos i = 0{\cdot}558$, while the nearest simple fraction $\frac{5}{9}$ is 0·555. . . . But whether 5 and 9 are still "small" integers must be left to every one's own judgment. In fine, the formula (2), *regardless of its significance or deduction*, gives the correct ionisation potential for $-\cos i = \frac{1}{2}$, and at the same time, for

$$-\cos i = \tfrac{5}{9},\ \tfrac{3}{5},\ \tfrac{2}{3},\ \tfrac{4}{5},$$

the observed Lyman lines λ_4, λ_3, λ_2, λ_1, respectively, the initial state being always that of He^+, and the final energy level being each time given by (1) with the corresponding inclination. Notice that for $i = 0$, $F = \pi/2$, and (1) gives 49/8 N*ch*, the familiar energy level of Bohr's older (untenable) ring model.

Whether the model of normal helium ($i = 120°$), with almost circular orbits, is dynamically legitimate, seems doubtful. Finally, a decision with regard to the dynamical possibility of the remaining four configurations, leading to remarkable coincidences, would require a thorough and complicated analysis, which the writer is not in the position to offer. Unless some new lines are discovered beyond 500 Å., the domain worthy of investigation in this respect, on either the accepted or modified dynamical and quantic principles, would extend only from $i = 120°$ to less than 177·63°, the latter being the inclination for which the right-hand member of (2) vanishes, when the system is ready to break up of its own accord.

L. SILBERSTEIN.

Rochester, N.Y., March 1.

The Nature of Light-Quanta.

IN a letter to NATURE of April 21, 1921 (vol. 107, p. 233), Sir Arthur Schuster pointed out that a quantum radiation could not, on account of the finiteness of its energy, $\epsilon = h\nu$, be regarded as homogeneous light of frequency ν, for homogeneity implies, strictly, the existence of an infinite train of waves of constant amplitude.

Since all attempts to find a type of nearly homogeneous light with total energy $h\nu$ have been comparatively unsuccessful, it seems worth while to consider the hypothesis that an approximately homogeneous type of light is the result of the *interference* of two or more quantum radiations of an elementary character.

Let us assume that an elementary quantum radiation, in the form of a plane wave travelling in the direction of the axis of x, is specified by an electromagnetic field in which the electric vector E is transverse to the direction of propagation and represented by a vector of type $f(x - ct)F$, where F depends only on z and y and represents in magnitude and direction the electric force in a two-dimensional electrostatic field, of finite energy W, arising from positive and negative charges situated within a small finite area A in the yz-plane.

If $f(x) = \dfrac{\sin px}{x}$, the total energy in this electromagnetic field is πpW and is thus finite in spite of the fact that there are electric charges travelling in

the direction of the waves with the velocity of light. These charges lie within a cylinder meeting the plane of yz on the boundary of A. The magnetic vector is perpendicular to the electric vector and equal to it in magnitude both inside and outside the electric charges. The Maxwell-Lorentz equations are satisfied everywhere, and the fact that we are able to specify a type of radiation the total energy of which is proportional to the maximum frequency $pc=\nu$ indicates that quantum theory may be quite compatible with these equations. That all frequencies up to pc occur is seen at once from the equation $\frac{\sin px}{x}=\int_0^p \cos qx \,.\, dq$. We are justified in regarding this type of field as elementary because, as Levi-Civita pointed out many years ago (*Comptes rendus*, t. 145, 1907), the electromagnetic force on the moving electricity vanishes everywhere and so the electricity moves freely under no forces and no forces are needed to keep it intact. In this connection it may be mentioned that the force of type $2\psi\nabla(\rho\sqrt{1-v^2/c^2})$, which has been used to balance the electric force in a suggested model of a stationary electron (*Physical Review*, September 1922), is also zero in the present case because $\psi=0$ and $v^2=c^2$.

Superposing two quantum fields with

$$f=\frac{\sin(p+dp)(x-ct)}{x-ct} \text{ and } f=-\frac{\sin p(x-ct)}{x-ct}, \text{ respectively,}$$

and with coincident cylinders (or light-darts, to use Silberstein's term), we obtain a wave of nearly homogeneous radiation of total energy $\pi W dp$. When the light-darts in the two fields are separate entities but close together, the total field still represents an approximately homogeneous type of radiation, but it also possesses some of the properties of a quantum radiation because the light-darts can be regarded as independent and one of them can be captured by an atom and its energy $h\nu$ absorbed while the other one escapes.

The composite field will behave like radiation of frequencies lying between ν and $\nu+d\nu$ when reflected and refracted if the elementary quantum-radiation behaves like light of frequency $\nu=cp$.

To test this point we have considered the reflection of our elementary quantum radiation at the surface of the moving mirror $x=ut$. The reflected wave proves to be one of the same type as the first, the electric vector being $-f(x+ct)$F, where $f(x)=\frac{\sin p'x}{x}$ and $p'=p\frac{c-u}{c+u}$.

Thus Doppler's principle holds just as if pc were the frequency of homogeneous light instead of the maximum frequency contained in the quantum radiation. The energy relation $\epsilon'=h\nu'$ still holds and it looks as if W could be regarded as a universal constant hc/π.

It should be remarked that the elementary radiant field considered here is simply a particular case of a more general type of simple radiant field in which the rays and light-darts issue from a moving point. An ordinary type of electromagnetic field can be built up by superposing two or more simple radiant fields of this type and proceeding to the limit. If, then, ordinary electromagnetic fields are to be regarded as composite, there is nothing strange in regarding an approximately homogeneous type of radiation as composite.

H. BATEMAN.

California Institute of Technology,
Pasadena, California,
March 5.

Spermatogenesis of the Lepidoptera.

I SHOULD be glad of the hospitality of the columns of NATURE to reply to two observers whose papers in the December number of the *Quarterly Journal of Microscopical Science* have only recently come under my attention. Dr. Robert H. Bowen, of Columbia University, has investigated the spermatogenesis of the Lepidoptera, a subject which formed the first part of my series of papers on the "Cytoplasmic Inclusions of the Germ Cells." His account differs from previous ones chiefly in two respects—he states that the mitochondrial part of the spermatid is not a skein or spireme but a plate-work, and what is a much more interesting objection, he denies the previous descriptions of the metamorphosis of this skein into a tail-sheath, and instead describes it as degenerating, and the tail region being formed of a new central substance.

In the same Journal, Mr. Graham Cannon has redescribed the louse mitosome, and supports Dr. Bowen's conclusion that this body is not a skein but a plate-work. Dr. Bowen agrees with me so far as the general appearance of the material is concerned, but in a long discussion brings up a number of reasons for supposing that the body in question is a plate-work something roughly like the head of a fancy chrysanthemum. Mr. Graham Cannon has also given a similar and short account of his reasons for supposing that this body is actually a plate-work formed by a system of vacuoles.

Some years ago when Prof. Doncaster was writing his latest book, he came to see the material illustrating my view that the acrosome is always formed in association with the Golgi apparatus. He was shown my preparations of Smerinthus testes, and objected then to my description of the mitosome or nebenkern as a spireme. Dr. Bowen and Mr. Cannon will be glad to know this. However, I never found any reason to alter my views, even with such distinguished opposition, because it seemed to me that whether the "spireme" was formed of a flat ribbon, or a round string, it was actually pulled out as the spermatid lengthened, much like a ball of string. The figure formed by the mitochondria of the spermatid is not a matter of importance so far as concerns the larger questions surrounding the study of the cytoplasmic inclusions.

When, however, we turn to the second objection brought forward by Dr. Bowen, we find a matter of considerable importance. Dr. Bowen's "central substance" was believed to be the partly unravelled or pulled-out mitochondrial skein; it is figured by me in Plate 25, fig. 47, of my paper. His account of this new substance being something apart from the nebenkern or mitosome, and of the latter not taking direct part in the formation of the tail, is worthy of reinvestigation.

Except for Dr. Bowen's new interpretation of the formation of the sperm tail, he adds nothing new to our knowledge of the spermatogenesis of the Lepidoptera. His account is valuable, however, because of the fact that it confirms my drawings of the appearances of the material already described by me. Some of his spermatid cells are effete and drawn from bundles which are in the process of formation of atypic sperms. The whole question will be dealt with by me in a full account elsewhere. I merely take this early opportunity of stating my position.

Mr. Graham Cannon's statements will also be examined at length elsewhere.

J. BRONTË GATENBY.

Zoology Department,
Dublin University,
April 9.

A Static or Dynamic Atom?

SOME writers still contrast the static atom of Lewis and Langmuir with the dynamic atom of Bohr, as if the two alternatives were mutually exclusive. It does not seem to be realised generally that any inconsistency there may have been between them has vanished completely with the publication of Bohr's later views on atomic orbits; speculations about chemical constitution based on the static atom can be translated directly into the language and conceptions of the dynamic atom.

The fundamental idea of Lewis is that non-polar combination consists in the sharing of electrons between atoms in such a way as to complete stable electronic configurations. If the sharing of an electron means the sharing of an orbit, and if the stable electronic configurations are those in which the groups of highest quantum number are completed, as they are in the rare gases: then the Lewis-Langmuir theory, expressed in terms of Bohr's conceptions, states that such compounds are formed when some of the electronic orbits, instead of surrounding one nucleus only, surround both, and therefore help to complete the quantum groups of both atoms. With this principle as a guide, it is merely a matter of linguistic alteration to interpret on the basis of a dynamic atom the conclusions which have been reached on the basis of the static atom.

Of course the question remains whether the theory can be true and whether such shared orbits are possible. This is a matter for quantum theory to decide. My last letter to NATURE on this subject (November 25, 1920, vol. 106, p. 408) succeeded in eliciting from Prof. Bohr the first statement of the later and most exciting developments of his theory; perhaps this one will be equally fortunate!

Until the question is settled, it would be waste of time to make the necessary translation, even in a few examples. But it may be well to point out that, if this interpretation of the "sharing of electrons" can be accepted, the task of explaining chemistry according to the Lewis theory will probably be facilitated. For it seems likely that some limitations at present imposed upon the forms of sharing and upon the stable configurations could be removed. So far as I can see, Lewis's principle that only pairs of electrons are shared, and Langmuir's principle (in the original statement) that the stable configuration is always an octet, are based not so much on definite facts as on the need of some guiding principle if speculation is to be limited. The limitations suggested by the identification of stable configurations with the completion, or partial completion, of quantum groups are not exactly those which are usually adopted at present; but once more, while the whole basis of the theory is so uncertain, the attempt to decide the constitution of particular compounds is premature.

NORMAN R. CAMPBELL.

The Zwartebergen and the Wegener Hypothesis.

CRITICS of the Wegener hypothesis have made a good deal of capital out of the northward deflexion of the folds of the Zwartebergen on approaching the west coast of Africa, but their failure to point out the cause of this deflexion seems to me to lay them open to the charge of advocacy which they so freely lay at Wegener's feet.

The deflexion is produced by the incidence of the chain on a massif of older rocks of the Swaziland System with a core of granite trending north-west. On nearing this resistant axis, the folds bend north-west and then north forming the Cederbergen. Finally, they flatten and die out northwards. It is clear that the existence of the granitic axis has interfered with the direct westerly continuation of the folds. The interference, however, is only local, for the Cederbergen do not continue for any distance to the north.

An exactly analogous deflexion occurs in the case of the Armorican folds in Ireland where they impinge on the highly resistant north-easterly trending Wicklow chain with its massive granitic axis. The folds turn north-east in Tipperary as they approach the granite and then north in Kilkenny and Queen's County, where they flatten out and finally disappear. The analogy is very perfect in that the final deflexion from the general trend of the folds is greater than would be brought about by a mere falling into line with the Wicklow chain.

Now, as every one is aware, the interruption along the line of the Wicklow granite does not stop the Armorican folds. They are renewed on the other side of St. George's Channel in southern Wales, where they once more assume their normal direction. If, therefore, we imagine the supposed Atlantic rift valley to have opened up along St. George's Channel, so as to leave Ireland attached to Newfoundland, we may profitably consider what would have happened when one of those irrepressible Germans had come along and announced that it once formed part of the British Isles, basing his argument on the fact that the Irish and Welsh folds, as well as other geological structures, fitted one another when the countries were placed in juxtaposition. The critics would at once have objected that the Armorican folds in Ireland on the west side of the Atlantic turned up northwards before they reached the coast, and therefore could not be regarded as a continuation of those of Wales. It is clear that the objection would have no force in this instance, so one may well ask whether it has any in the actual case of Africa and South America.

W. B. WRIGHT.

Manchester, March 31.

Egyptian Water-Clocks.

PERMIT a brief correction to the paragraph in NATURE of April 7, p. 479, on the casts presented to the Science Museum. The variable divisions of the water-clocks are not for different lengths of day, but compensations for the changes of viscosity of water, over 9° and 12° F. respectively. This is proved by the extremes being nearer to the equinoxes than to the solstices, to harmonise with the slow passage of heat through massive temples. Further, the conical form of the clepsydra of 1400 B.C. was to compensate for the greater flow under fuller pressure, the form being a near approach to a portion of a parabola. Thus the variation of pressure was as 1 : 3·7, and the water varied as 1 : 2·9 to meet this.

W. M. FLINDERS PETRIE.

A Permanent Image on Clear Glass.

AFTER silvering an ordinary clock glass (about 5 in. diameter) on the convex side, I noticed on removing the wax, with which the concave side had been protected, that a perfectly distinct image of a small child's head had been rendered visible. The image is a photographic "positive."

It occurred to me that the clock glass had possibly been a photographic plate at some earlier time. Presumably it was a plane surface then. In giving the glass the curvature requisite to a clock glass it would be expected that any silver which may have been deposited while the plate was flat would have been disturbed when the glass had been moulded in a molten condition to its present shape. The image, however, is not distorted in the slightest degree.

I should be glad if any readers of NATURE would supply an explanation of the production of this image. ERIC ROBINSON.

Bedford School, Bedford,
March 24.

I MUST thank the Editor for the opportunity he has given me of examining the very interesting silvered reflector specimen submitted by Mr. Robinson.

The image of the child's head has evidently a photographic origin, as Mr. Robinson suggests, but that the glass was at some earlier time a photographic plate that had later been heated and allowed to settle down in a suitable mould seems to be improbable, for the following reasons :

The image occupies only a small part, about an inch square, near the edge of the plate, the remainder of which shows no photographic details. There is, as Mr. Robinson remarks, no evidence of distortion at the curved portions, and a close examination of the surface shows none of those minute fractures that are usually visible when an old photographic plate is stripped and silvered.

When the image is examined closely, it is seen that there is a sharp line of demarcation especially at the right-hand side and the bottom, which suggests that at some time the head has been cut from a photograph and pasted inside the clock face. As the result of contact, or possibly under the action of the light, the image has then been impressed upon the glass. At some later date the photograph has been removed but the image on the glass has persisted and been rendered visible by silvering.

There are many examples of images being formed in the manner described on glass surfaces. A "To Let" notice pasted inside a window often becomes imprinted on the glass, and the image may persist thereafter for a very long time. Recently I observed on a tramcar window the wording of an advertisement that had been pasted on the glass and later removed. Silvering would of course make the images much more conspicuous.

In the hope of being able to reproduce Mr. Robinson's specimen, two photographs were attached with water inside a similar clock face and exposed to the light of an arc lamp for four hours. After the photographs had been removed the surface was thoroughly cleaned and silvered. Notwithstanding the briefness of the exposure, the images were then quite recognisable.

As there was reason to think that the appearance might be wholly or partly attributable to contact rather than exposure to light, a glass surface was cleaned with caustic potash and upon it there was roughly sketched a face by means of a quill moistened with stannous chloride. The liquid was allowed to remain for two minutes on the surface of the glass, which was then recleaned by means of a cotton-wool pad and weak caustic potash solution. After silvering, the details of the sketch could be observed, although previously no traces were apparent.

Another plate was similarly treated but not silvered. When this plate is breathed upon, the face can be distinctly seen.

The subject is one that deserves fuller investigation.

So materialistic an explanation as the above is not, I fear, so attractive as a psychic one.

JAMES W. FRENCH.

Anniesland, Glasgow, April 9.

Tactile Vision of Insects and Arachnida.

IT would be interesting to know more details of the research carried out by Mr. J. P. O'Hea on the "so-called eyes in insects and arachnida" (NATURE, April 14, p. 498, in connexion with Commander Hilton Young's suggestion), from which he arrives at the surprising conclusion that "the organs generally known as eyes do not act as organs of vision." The species Mr. O'Hea mentions are the house-fly, red ants, *Tegenaria domestica*, and "many of the Epeiræ." We have here an assortment of which the power, and even manner, of vision are scarcely comparable.

Taking first the spiders, sight plays practically no part in the life of the common Epeirides; the eyes, so far as one can see, simply serve to distinguish light from darkness, and form no clear image. This is not quite true of Tegenaria (the other spider mentioned). A sudden movement of the hand, when the spider comes out to take a fly, I have known to send it back (this is also true of *Agelena labyrinthica* and others). In this case, however, it is a large moving object which frightens the spider, and it will hesitate in its attack if the insect cease to struggle, so that it does not find it by sight.

As for the red ants (the species is not stated), we have the mass of Lord Avebury's work, as well as that of Forel and many others, in determining the part vision plays. One of the simplest cases is that quoted by Forel ("Senses of Insects," pp. 124-128), in which he found that specimens of *Formica pratensis* experienced considerable difficulty in finding the nest when their eyes were varnished (the antennary sense, however, playing the most important part).

It is in the case of the house-fly that Mr. O'Hea's conclusions are most surprising. He maintains that if one gradually brings the hand up to a fly on a window-pane, "if it be a vigorous specimen, [it] will evade the caress," whereas if one approaches it from the other side of the pane the fly takes little notice. His conclusion is that the fly recognises the approach of the hand, not by vision but by currents of air due to the motion of the hand or by convection currents due to heat of the same.

I have lately had occasion to catch a number of flies (*Musca domestica* and *Calliphora vomitoria*), and have found that one of the best ways was to bring a glass tube slowly and continuously up to the fly (any sudden movement almost always causes the fly to escape). If the movement is quite steady, the fly does not realise the situation until covered by the tube; it cannot apparently appreciate a slow movement.

When the fly is on the other side of the glass we have several factors to consider. For example, if the fly is *outside*, its field of vision *below itself* will be limited owing to bright reflections all round (its eye being close to the glass); hence movements from inside, even if the fly could see below itself, would have to be sudden and on a larger scale to disturb it.

The most obvious test to apply is as follows: Approach the under side of the fly (1) through glass, when, as stated, it often takes no notice; (2) through trellis (such as a meat-safe is made of), when, in my experience, the same thing occurs. This seems to dispose of the idea that the fly is affected by convection currents. The explanation of the facts I should suggest to be somewhat as follows: The surface of the compound eye available to the fly for looking downwards is smaller than that on the top of the head. Moreover, the lower portion is never used when the fly is resting normally on a solid opaque body and the fly has only to take into account attacks from above. An attack from below (when the fly is at rest) is outside its normal experience. One may recall also that the ocelli are situated on the top of the head and are usually considered to be useful for close vision. The experiment, to be in any way conclusive, should be repeated with the eyes of the fly varnished.

Mr. O'Hea must, however, have more facts which enable him to deny the use of an insect's eyes for vision in the face of all the work of Lord Avebury, Plateau, Forel, and many others.

As for Arachnida, an immense number of examples could be quoted as indicating power of vision. The following are obvious (and are cases where "convection currents" are definitely excluded):

A male Attid will start to dance before the female, though a glass partition separate them, and he turns his head to watch her as she moves.

I have at present two specimens of *Lycosa Narbonensis*, which, when out of their burrows, will dart back when a sudden movement is made near them, that is within about three yards. (They are always under glass, so that convection currents will explain nothing.) A slow approach, as with the fly, does not disturb them.

It seems to me that, in testing, Commander Hilton Young's hypothesis, we cannot assume the absence of insect vision on such slender evidence as that brought forward by Mr. O'Hea. We must either experiment with species which are *known* to possess *absolutely no power of sight*, or obliterate the eyes with a varnish, and *then* see how the insect behaves in the neighbourhood of a solid body.

G. H. LOCKET.

Salmon's Cross, Reigate, Surrey,
April 15.

Science and Economics.

PROF. SODDY is an eminent chemist and physicist, and it is consistent with his own investigations that he should seek for the "natural fundamental basis of the economic system under which we perish" (NATURE, April 14, p. 497). If the natural basis of the system be such as to cause us to perish, the object of a re-examination is, perhaps, to alter Nature and reconstruct *de novo*. Or, does Prof. Soddy mean that there are natural economic laws of which we are, as yet, not aware, and for which we should search? We know, however, that nineteenth-century economists enunciated natural laws of economics such as *competition* (survival of the fit) and *supply and demand* (action and reaction). These laws, nevertheless, were not "natural" to economics; they were adapted from Nature, as then expounded, and applied artificially by the governments in certain countries.

Prof. Soddy now says, and with some reason, that the present economic system is an offence against common sense. It seems then that the natural obvious truths of the nineteenth century as interpreted economically are, in this century, both unscientific and senseless. Many no doubt will agree with him that the complex modern financial system which evolved through several centuries *pari passu* with science, and admirably served to stimulate, restrain, and direct the desires and ambitions of an imperfect human race, does not function as responsively as it did. Age may be the cause; it has not renewed itself by new forms of thought as has science. But, whatever the cause, one ventures to disagree with Prof. Soddy when he says that no one pretends to understand the system. This is true only as one might say "no one pretends to understand the 'atomic' theory": a few do—that is, those who conduct the operations. Certain axioms hold good until new conditions are introduced; but it is somewhat easier, one would think, to find the formulæ necessary to control operations under new conditions in a laboratory than in the world of human affairs. In the former, mathematics are at hand, but of what assistance are these scientific methods in dealing with complex and unequally developed human beings whose conflicting desires and opinions cannot be mathematically computed and resolved by formulæ?

Again, Prof. Soddy's assertion that the production of wealth is now "a relatively finished science" has a ring of finality hitherto unassociated with science. Many civilisations have shown evidences of great wealth, and its *production* is always a finished science at any time in an epoch, though relatively so to another. In our own day the need for human labour has not yet been entirely eliminated. It is even less probable that the *distribution* of wealth will ever become a finished science—at least, until "Earth's last picture is painted." Were the dispensers of credit (whether by patronage or "democratic control") to achieve a temporary perfection in adjusting the desires and deserts of the social hierarchy even in regard to material things, the mere force of individuality in human beings would upset the balance in time, and the fact of evolution makes this event inevitable, as history shows. There may be a science of the distribution of wealth, and, if so, it is probably associated with the science of government, an art in which rulers and princes of earlier times were especially trained; but one must conclude that its principles are not those of applied physics, for mankind cannot be controlled, transmuted, and led so rapidly and readily on the path of evolution as can the "elements" in the physicist's laboratory.

The ultimate basis of credit in any age is character and ability, on which have been founded the Codes of Laws and social formulæ of all great civilisations from the earliest Laws of Manu. It may be as well, therefore, for the preservation of our modern knowledge, that the system by which "tokens of wealth" are distributed should not be radically changed until character is once more clearly defined and appreciated by all classes.

W. WILSON LEISENRING.

Oakley House, Bloomsbury Street,
London, W.C.1, April 16.

Effect of Plant Extracts on Blood Sugar.

(BY CABLE.)

IN the early days of my investigations in connexion with insulin, I predicted that whenever glycogen occurred in Nature an insulin-like substance would also be found. Putting this theory to the test, I obtained positive results first with clam tissue, and later with yeast. This result was obtained during the latter part of January. In the light of this latter result, my mode of reasoning was changed. If yeast contains an insulin-like hormone, other plants may also contain it. Extracts of tissue of a variety of the higher plants were, therefore, prepared, and the effect of subcutaneous injection of these extracts upon the blood sugar of the normal rabbit was ascertained. The effect of certain plant extracts upon the blood sugar of depancreated dogs was also studied. Extracts made from onion tops, onion roots, barley roots and sprouted grain, green wheat leaves, bean tops, and lettuce were found to produce marked hyperglycæmia in normal rabbits. The day following the administration of an extract of green onion tops to a depancreated dog with a blood sugar of 0·190 per cent., a blood sugar of 0·090 per cent. was observed. The results of this investigation were communicated to the Society for Experimental Biology and Medicine at the meeting in New York City on March 21, when I suggested the name "Glucokinin" for this new plant hormone. Since that date I notice in NATURE of March 10 a letter by Messrs. Winter and Smith stating that they have obtained positive results with yeast extracts. These authors would, therefore, share coincident priority with me in this particular.

J. B. COLLIP.

Biochemical Laboratory, University of Alberta,
April 21.

The Interferometer in Astronomy.[1]

By Prof. A. S. EDDINGTON, F.R.S.

TO the naked eye the stars and planets equally appear as points of light. A telescope magnifies the planets into discs, but no telescope is large enough to render visible the disc of a star. We can calculate that a lens or mirror of 20 ft. aperture would be needed to show us even the largest star disc; the construction of such an instrument, if not hopeless, is far distant. We have considerable knowledge as to the size of stars, but until recently it was all found by indirect calculation; no test had made out the image to be other than that of a geometrical point. At the risk of going over familiar ground I must consider briefly the mode by which a telescope forms an image—in particular how it reproduces that detail and contrast of light and darkness which betrays that we are looking at a disc or a double star and not a blur emanating from a single point. This optical performance is called resolving power. Resolving power is not primarily a matter of magnification but of aperture; provided we use an eyepiece of reasonably high power the limit of resolution is determined by the size of aperture of the object-glass.

To create a sharply defined image the telescope must not only bring light where there ought to be light, but it must also bring darkness where there ought to be darkness. The latter task is the more difficult. Light waves in the æther tend to spread in all directions, and the telescope cannot prevent individual wavelets from straying on to parts of the picture where they have no business. But it has this one remedy—for every trespassing wavelet it must send a second wavelet by a slightly longer or shorter route to interfere with the first, and so produce darkness. This is where the utility of a wide aperture arises—by affording a wider difference in route of the individual wavelets, so that those from one part of the object-glass may be retarded relatively to and interfere with those from another part. A small object-glass can furnish light; it takes a big object-glass to furnish darkness.

Recognising that the success of an object-glass in separating double stars and other feats of resolution depends on the production of darkness in the proper place by interference between the waves from different parts of the aperture, Michelson asked himself whether the ordinary circular aperture was necessarily the most efficient for giving the required interference. Any deviation from the circular shape is likely to spoil the definition of the image—to produce wings and fringes. The image will not so closely resemble the object viewed. But, on the other hand, we may be able to sharpen up the tell-tale features. It does not matter how different the image-pattern may be from the object, provided that we are able to read the significance of the pattern. If we cannot reproduce a disc, let us try to produce something which is *distinctive* of a disc.

A little reflection suggests that we ought to increase the resolving power by blocking out the middle of the object-glass and using only two extreme regions on one side and the other. For these regions the difference of light-path is greatest, and the corresponding wavelets are the first to interfere; they are the most efficient in furnishing the dark contrast needed to outline the image properly.

But if the middle of the object-glass is not going to be used, why trouble to construct it? We are led to the idea of using two widely separated apertures, each involving a comparatively small lens or mirror—after the pattern of a range-finder. That is much easier to construct than a huge lens circumscribing both apertures.

It is one thing to detect a small planetary or nebular disc; it is another thing to make a close measure of its diameter. It is one thing to detect the duplicity of a star; it is another thing to measure the separation of the components. Michelson's first experiments were directed not towards performing feats of resolution beyond what had previously been attained, but towards improving the accuracy of measurement. He applied his method first to measuring the diameters of Jupiter's satellites—discs which are easy to detect, but very difficult to measure trustworthily with an ordinary micrometer. But it is easier to understand the application of the method to measurement of double stars than to the diameters of discs; and I shall therefore speak more particularly of the double-star problem first, although that is not the historical order.

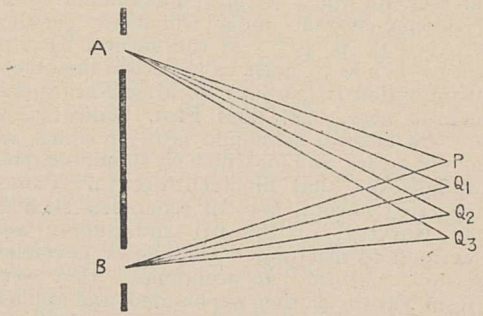

FIG. 1.

Consider light coming from a distant point and passing through two small apertures, A and B, the rest of the object-glass being blocked out (Fig. 1). From each aperture the light disturbance diverges in all directions, and our problem is to find the nature of the luminous pattern formed in the focal plane, this pattern constituting the image which is viewed and magnified by the eyepiece. At the point P (where, according to geometrical optics, the single point-image ought to appear) we have full illumination because the waves from the two apertures have equal paths, AP and BP, and reinforce one another. A little to one side we have another point of full illumination, Q_1; the paths, AQ_1 and BQ_1, are unequal, but differ by exactly a wave-length, so that the waves again arrive in the right phase to reinforce one another. Similarly we shall have a series of points of full illumination, Q_2, Q_3, etc., where the path-difference amounts to 2, 3, etc., wave-lengths. Intermediately there will be points of darkness where the path-difference is $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$ wave-lengths, and the waves arrive in opposite phase and

[1] From the presidential address delivered before the Royal Astronomical Society on February 9, on presenting the gold medal of the Society to Prof. A. A. Michelson.

cancel one another. The light-pattern viewed by the eyepiece is thus a line of alternate bright and dark fringes. At first sight it might seem that the fringes would continue of equal brightness to a great distance; but actually they soon fade away, because in the more oblique directions there is interference, not merely between the two apertures, but between different parts of the same aperture. In fact the fringes appear as fine detail in the midst of the small diffraction disc which would be formed by either of the apertures singly.

Arrange that the two apertures are movable, and widen their distance apart. The points Q_1, Q_2, Q_3 now come closer together, that is to say, the fringes contract. Decrease the distance and the fringes spread out. It is a simple matter to find a formula giving the width of the fringes for any given separation of the apertures.

When the object viewed is a double star—two points of light—each point will produce its own line of fringes, and these will be superposed if the double star is a close one. It may happen that the two systems of fringes are in step, in which case the alternate bright and dark spaces will be conspicuous: but if they are at all out of step the pattern will be blurred. Remembering that we can alter at will the width of the fringes by varying the separation of the apertures, we can adjust them, so that the bright fringes for one component coincide with the dark spaces for the other component. If the two systems are of equal brightness one system will fill the gaps in the other, leaving merely a line of uniform brightness; if the two components are of unequal brightness the same adjustment will give minimum visibility of the alternation of light and shade. Varying the distance between the apertures this critical position can be fixed with considerable precision; and for close double stars of not too unequal magnitude the separation is measured in this way much more accurately than with a micrometer.

The disc of a single star or planet is likewise measured by finding a position of the apertures for which the fringes disappear. It is not now a problem of two points producing overlapping fringes, but every point of the circular disc produces a fringe-system, and the effects must be summed. When the diameter of the disc is 1·22 times the width of the fringes (*i.e.* the distance from one bright fringe to the next) the integrated effect is uniform illumination and the fringes disappear altogether. It is not much use trying to see in one's head a result which is more fittingly the subject of algebraic calculation; but we may notice in a general way that with this ratio the two outer quarters of the disc fall at places where the central half is producing dark spaces. That indicates roughly how the different portions of the disc compensate one another. The observation consists in varying the separation of the aperture until the fringes disappear; the diameter of the disc is then 1·2 times the fringe-width calculated for that separation.

The possibilities of a method of this kind had been explored to some extent before Michelson took up the problem; indeed Stéphan in 1874 had attempted unsuccessfully to detect the discs of stars by this means. We owe to Michelson the practical demonstration of its success. His first paper appeared more than thirty years ago in the *Philosophical Magazine* for July 1890. The next year he followed up the theory by measuring the diameters of the four satellites of Jupiter at the Lick Observatory. The method proved entirely successful, and his measures were afterwards closely confirmed by Hamy at the Paris Observatory in 1899 using the same device. The great value of the method seemed to be proved; it was thoroughly tested; and it forthwith lapsed into oblivion.

In 1919 Michelson again took up the matter with energy. He made observations in August with the 40-in. refractor at Yerkes which were found to be encouraging; and he went on to use first the 60-in. and then the 100-in. at Mount Wilson with the more ambitious design of surpassing the highest resolving power yet reached. At Mount Wilson he had the co-operation first of J. A. Anderson and afterwards of F. G. Pease. A great success was quickly obtained with the double star Capella. Capella is a spectroscopic binary with a period of 104 days. It was known that the distance of its components must nearly approach the limit of visual detection, but attempts to observe it visually had failed. (I may remark that that is a rather controversial statement to make—particularly at the R.A.S.—but the controversy is now ancient history.) With two narrow apertures in the beam from the 100-in. mirror the fringes were observed and then brought to minimum visibility by varying the position angle and separation of the apertures. The changing position angle and distance were traced through the revolution. Anderson's measures, afterwards continued by Merrill, have given a very accurate orbit. The separation of the two components varies from 0·04″ to 0·05″. From a comparison of this visual orbit with the spectroscopic orbit we find the parallax of Capella and also the mass. The parallax is 0·063″, and the components are respectively 4·2 and 3·3 times as massive as the sun. The parallax does not differ much from that given by trigonometrical and spectroscopic determinations; but these were very rough values, whereas the interferometer parallax is presumably of the highest order of refinement. I suppose that the mass determinations are about the best we have for any star.[2] But what is especially important is that Capella is the *only giant star* for which we know both the mass and the absolute luminosity.

I may perhaps be allowed to refer to a personal interest in this first big result of Michelson's method. Capella now supplies the chief lacking constant in the radiative theory of stellar equilibrium, for which I had waited five years. It is, I think, generally conceded that the absolute magnitude of a giant star mainly depends on its mass, and theoretical formulæ can be found expressing the law of dependence. But we need to know one pair of corresponding values in order, as it were, to anchor the formulæ. Hitherto that correspondence could only be guessed roughly from statistical knowledge of the average luminosity of giant stars and an estimate of the corresponding average mass based on our general knowledge of the masses of stars (which, unfortunately, relates chiefly to dwarf stars). Having now the exact figures for Capella, we can substitute a precise determination

[2] The masses of α Centauri, Sirius, and Procyon may have about the same accuracy, but I do not think that any others reach this standard.

instead of the provisional estimate; the change is by no means unimportant, the original estimate having been considerably in error.

Capella would have been slightly beyond the theoretical resolving power of the 100-in. if used in the ordinary way, though an elongation might have been detected. Resolving power was actually gained by blocking out the mischievous central portion of the aperture. But now came the final step—to produce fringes with a greater path-difference than any telescope yet constructed could provide. In 1920 a 20-foot interferometer, designed by Michelson and Pease, was constructed, in which the two interfering apertures could be separated to a distance of 20 ft. This was used in conjunction with the 100-in. mirror, which helped to bring the two beams together to produce their fringes. One might say that Michelson was now employing a 20-foot mirror; only, since he was only intending to use two small areas at its edges, he economically constructed those particular areas and left the rest of the mirror to imagination.

On July 10, 1920, the great 20-foot beam was placed across the telescope. On December 13 success was attained, and the diameter of Betelgeuse was measured. Its interference fringes had totally disappeared when the mirrors were at 10 ft. separation, although the other stars showed them. The deduced diameter was 0·045″—about the same size as a halfpenny fifty miles away.

Michelson's visits to Mount Wilson were limited to the summer months, and he was not present when this result was obtained. When he returned in 1921 he found his collaborators much occupied in trying to find some plan of obtaining definite measures of the visibility of the fringes instead of vague judgments. He suggested the plan of using two apertures, one fixed and the other variable; a difference in the size of the apertures reduces the visibility to a definite extent, depending on the ratio of the two apertures. Finally, a comparison apparatus was constructed with one square aperture of 4 in. and the other a square variable from 4 in. to zero, in order to afford a definite scale of visibility.

In the early trials it took days to find the fringes, but as gradual improvements were made a few hours' work on the first night of a series of observations sufficed; the subsequent settings being made in a few moments.

I need only touch very briefly on later developments. Diameters of Antares, Aldebaran, Arcturus, and β Pegasi have since been measured. But, of course, the discs of most stars are far below the limits for a 20-foot instrument. Prof. Hale is now constructing a 50-foot interferometer, and it is estimated that thirty or forty stars will be within its grasp. There is no need for a large mirror, and the use of the 100-in. in conjunction with the first interferometer was rather a luxury. The 50-foot is of different design, and will not depend on any other telescope. All the diameters of stars measured up to the present confirm very closely the theoretical values that had been predicted for them. The enormous actual size of these stars—the earth's orbit could be placed entirely inside Betelgeuse—is a picturesque feature of the results; but that was a confirmation of facts already established almost beyond doubt.

It is not unlikely that interesting bypaths may be opened up. Considerable fluctuations in the diameter of Betelgeuse have been found, which may or may not be due to varying definition. The star is an irregular variable showing also changes of line-of-sight velocity, and the correlation of varying diameter with these other fluctuations would be of great physical interest if it turns out to be genuine. Michelson has pointed out that it is theoretically possible to determine by the interferometer the distribution of light over the disc—the law of darkening at the limb. That is a conceivable development for the future.

Sunlight and Disease.[1]

By Dr. C. W. SALEEBY.

"IN the beginning, God said, Let There Be Light." In or before the eighth century B.C., Zarathustra, foremost among many sun-worshippers in many ages, taught the cult of the sun and the green leaf and thrift, in place of pillage and murder. In the beginning of medicine, Hippocrates, practising at Cos in the temples of Æsculapius—son of Phœbus Apollo, god of the sun and medicine and music—practised the sun-cure. In the beginning of our era, Galen and Celsus used the sun. In the Dark Ages, by a pitiful misconception, the cult of the sun fell into desuetude as a species of pagan Nature-worship, and ill persons were treated alike in physical and in intellectual night. Tuberculosis and other ills were treated by the Sovereign touch, reputed to cure the "king's evil."

In the second half of the nineteenth century, we find certain heralds of the dawn. In 1856, Florence Nightingale vigorously but vainly protested against the orientation of Netley Hospital, observing that no sunlight could ever enter its wards. In 1876, Sir Benjamin Ward Richardson praised sunlight in his "Hygeia, The City of Health." In 1877, Downes and Blunt showed that sunlight will kill anthrax bacilli. In many writings at this period, John Ruskin upheld sunlight and declaimed against the "plague-cloud" of smoke above our cities. In 1890, Dr. Theobald Adrian Palm (*nat.* 1848), who still practises medicine at Aylesford, in the Garden of England, showed by the geographical method that lack of sunlight is the chief factor in the causation of rickets, and added an admirable series of recommendations accordingly.[2] His paper was entirely ignored, and I found it in America, thanks to an American bibliographer. Robert Koch and others showed that sunlight kills tubercle bacilli. In 1893, Niels Finsen began to cure lupus, a form of cutaneous tuberculosis, by the local use of sunlight, and Sir James Crichton-Browne made observations to the same effect in this country. In 1900, on May 1, the London Hospital

[1] From a discourse at the Royal Institution on March 9.

[2] "The Geographical Distribution and Ætiology of Rickets," *The Practitioner*, October and November 1890.

began the cure of lupus by the local use of sunlight, thanks to the really effective Sovereign touch of Queen Alexandra, who was instrumental in bringing her young fellow-countryman's idea from Copenhagen.

In 1903, Dr. A. Rollier opened at Leysin, in the Alpes Vaudoises, the first clinic for the treatment of so-called surgical tuberculosis by sunlight; and in 1910 he applied his idea to prevention by the establishment of the "school in the sun," at Cergnat, just below Leysin.[3] In 1914, he published his book, "La Cure de Soleil," but the world catastrophe of that year caused it to be overlooked. In this country his methods have been followed recently by Sir Henry Gauvain, at the Treloar Hospital at Alton and Hayling Island, where very simple sheds and solaria serve to achieve results never approached by Netley, the pretentious and misplaced architecture of which exists in the same county to point the contrast between its century—the last of the ages of darkness—and the dawn in our own. In a very few other places, also, such as the Queen Mary's Hospital for Children at Carshalton, under Dr. Gordon Pugh—photographs of which from the air show a series of three-sided solaria strongly resembling the health temple at Cos,—at Leasowe near Liverpool, at Perrysburg near Buffalo in the United States, and, following a recent lecture of mine, at the Heritage Craft Schools, Chailey, Sussex, the sun-cure is employed. At several others, which I have visited, the sun-cure is said to be employed, but is not, the elements of the matter being unknown to the persons in charge.

The results of heliotherapy, as seen in person, or recorded in Rollier's radiographic and clinical atlas of 1914, or shown by means of illustrations, are unapproached, for certainty, safety, ease, beauty, restoration of function, and happiness during and after treatment. No explanation of them, to be called intelligible or adequate, is offered by any of its practitioners. Being myself without patients or laboratories, I have used only the geographical method, and have found, at each place studied, a tendency to believe that the various factors there present are essential for the results obtained. In the mountains, altitude is insisted upon; at the sea, the argument for "helio-Alpine" is replaced by an argument for "helio-Marine." In high latitudes, the Mediterranean is described as impossible for sun-cure; on visiting the Mediterranean, I found the sun-cure gloriously successful on the French and Italian Riviera, and there are similar reports from Spain. The fundamental bases were lacking for a superlatively successful empirical practice, conducted by various clinicians under widely varying conditions and in ignorance, for the most part, of each other's methods. No rational statement of the scope of heliotherapy could be obtained, some strongly denying, while Rollier strongly averred, that tuberculosis is amenable to the treatment when it happens to be situated in the lungs, as it is amenable when situated elsewhere. In his volume of 1914, Rollier mentioned certain other conditions besides tuberculosis, such as rickets, a non-bacterial disease, but the only explanation of the sun-cure that he offered was based on the antiseptic action of sunlight, while Gauvain explicitly regarded the sunlight as only an adjuvant in his method.

Clearly the need was for a properly co-ordinated scientific inquiry into the action of sunlight upon the body in health and disease. We were using it as we used digitalis for the heart before pharmacology (to compare a great thing with one relatively trivial); we needed a true physio-pharmacology of this incomparable medicament. My demands (*e.g.* in NATURE, December 8, 1921, p. 466; January 5, 1922, p. 11) for such an inquiry were met, after six months, by the Medical Research Council, early in 1922, and from the date of the appointment of the Special Committee, under the chairmanship of Sir William Bayliss, a new chapter in clinical and preventive medicine, I believe, will be seen to begin, its provisional opening being the new and largely rewritten translation into English of "La Cure de Soleil,"[4] on which I resolved immediately after my first visit to Leysin.

Already we have at least made it clear to all critics that the action is due to the sun's light and not to its heat. So long ago as 1779, Ingenhouss showed that the dissociation of carbon dioxide by the green leaf is due to the sun's light and not to its heat. Yet, in several instances, the sun-cure has been tried, with calamitous results, by clinicians who, making no inquiry into the matter, have exposed the unaccustomed chests of phthisical patients to the mid-day sun, perhaps for an hour or two, with natural results in fever and hæmoptysis. Already, also, the idea that the light is less valuable in killing the infective agent than in raising the bodily resistance to it—an idea to which I invited attention nearly twenty years ago, at the death of Finsen—has come into the clinical mind. Since last August in the Light Department of the London Hospital—which has done such splendid though limited work on the older hypothesis, since 1900—the general light bath has been used as well as the local treatment, and cases which resisted the latter have been completely cured by general exposure of the nude skin to the electric arc lamp, without local irradiation. We must use a combination of light and cold, which I have been commending for some time on the evidence of visits to Canada, where a magnificent childhood, free from rickets, thrives in extreme cold, thanks, as I believe, to a brilliant sun.

In various American laboratories the subject is now being advanced: notably in Columbia University, New York, under Dr. Alfred F. Hess and his fellow-workers. They attribute the major part of the action of the sun to the ultra-violet rays, by which, in experimental animals and also in infants, they are able to cure rickets with great speed, ease, and certainty, and to increase very markedly the phosphorus in the blood of infants on a constant diet. When I saw this experimental and clinical work in New York last December, the result had already been reached of demonstrating an annual curve, from month to month, of phosphorus in the blood of infants, with a maximum in June-July, and a minumum in March, corresponding with the monthly height of the sun in New York. By radiographic study of the bones of infants, it had also been shown that no new cases of rickets occur

[3] The "school in the sun," in summer and winter, was demonstrated after the discourse by means of a film.

[4] "Heliotherapy," by Dr. A. Rollier, with forewords by Sir H. J. Gauvain and Dr. C. W. Saleeby. Oxford Medical Publications, 1923.

in New York in June-July, and the maximum number occur in March. Dr. Hess now informs me that the calcium content of the blood follows the same curve as the phosphorus content. Among earlier noted seasonal effects of sunlight, quoted by Hess in his latest paper, are the presence of increased iodine in the thyroid of cattle from June to November, and the greater resistance of guinea-pigs to aceto-nitrile poisoning in summer.

Hess and his workers have also begun the study of various clothing materials in this connexion, and find that they vary in their power of permitting or obstructing the action of light. Specimens of a mercerised cotton, one white and the other black, otherwise identical, the former allowing light to act and the latter interfering with it, have been examined by me, and I find no difference, due to the black dye, in the spacing between the fibres of the material. But I understand that the Department of Applied Physiology of the Medical Research Council has found, in a series of observations as yet unpublished, that the biological action of light can be graded by temperature. I am in hope that these specimens of material may be studied by the delicate methods associated with the name of Prof. Leonard Hill, and that it may be found that the black material produces a higher temperature than the white of the subjacent skin, thus prejudicing those unknown and beneficent chemical reactions which appear to need light and cold for their development.

The belief grows upon me that the asserted futility of heliotherapy in phthisis is due to the overheating of the patients in the sun. I think that a new chapter will open in the treatment of that disease when practitioners acquaint themselves with the principles and practice of heliotherapy before exposing their patients to the sun.

The power of sunlight and of cod-liver oil in rickets has suggested to Prof. Harden that the light may cause the skin to produce vitamin A for itself—though no instance of the synthesis of a vitamin by the animal body is known. The most recent work at the Lister Institute shows that light is unable to replace vitamin A completely, but appears to make a small quantity more effective. Miss Coward's work shows that vitamin A is present in the parts of flowers which contain carotin. Sir William Bayliss has suggested to me that the production of this vitamin in green plants is a function of the carotin rather than of chlorophyll, and that probably the carotin acts as a sensitiser for ultra-violet rays. In this connexion we must remember that pigmentation of the skin is a marked feature of the sun-cure, and that patients who do not pigment well do not progress well. No one who has seen and touched the typical pigmented skin of a heliotherapeutic patient can doubt that very active chemical processes are there occurring. Perhaps we should regard the skin less as a mere integument than as an organ of internal secretion. The pigmented skin under the sunlight is surely that; and we may ask whether it contributes, as Sheridan Delépine suggested,[5] to the making of hæmoglobin. I owe also to Sir William Bayliss the information that Dr. H. H. Dale, a member of his committee, has shown that smooth muscle can be made to contract by ultra-violet rays.

Aerial and other photographs of Manchester, and the Potteries, and of Sheffield, taken at successive hours on Sunday and Monday, demonstrate the obstruction of sunlight by our urban smoke, the industrial and the domestic chimney being both responsible: but while Sheffield deprives itself of more than half its sunlight, Essen is absolutely smokeless, and Pittsburg, which I have visited for the purposes of this inquiry, has abolished 85 per cent. of its smoke. Sections of the lungs of an agricultural labourer and a typical urban inhabitant of our country, the latter being heavily infiltrated with smoke, illustrate a cognate aspect of our subject.

Yet another point is illustrated by recent work of Hess, which shows that the milk of cows fed on pasture in the sunlight maintains the growth and health of young animals, whereas the milk of cows fed in shadow and on vitamin-free fodder will not maintain life. Our children are thus disadvantaged in winter by light-starvation, and by the defect of the milk of light-starved cows.[6]

Photographic study of houses and housing on both sides of the Atlantic illustrates the problem of urban light-starvation. Finding New York smokeless in 1919, I later made investigations with the aid of Dr. Royal S. Copeland, the Health Commissioner of that city, and found that the death-rate from pulmonary tuberculosis had been reduced by one-half in the period, 1905–1919, of the operation of the sanitary regulation against smoke.[7] The restoration of sunlight to our urban lives is the next great task of public health in this country.

"There is no darkness but ignorance," as Shakespeare said. In every sense we need "more light." Then we must apply our knowledge, less for heliotherapy than heliohygiene, until we have banished what I call the diseases of darkness, and it may be said of us that "The people that walked in darkness have seen a great light, and they that dwell in the land of the shadow of death, upon them hath the light shined."

[5] *Journal of Physiology*, vol. xii., 1891, p. 27.

[6] To some extent, Antipodean sunlight, in the form of dried milk from New Zealand, comes to the rescue.

[7] The smoke prohibited in New York, or in Winnipeg, where I found similar regulations, need not, as in our futile Public Health Act, be "black." See "The Eugenic Prospect" (Part II., "Let There Be Light"), by Dr. C. W. Saleeby. (Fisher Unwin, London; and Dodd Mead and Co., New York, 1921.)

Domestic Animals in Relation to Diphtheria.

THE perennial alarm of the possible transmission of diphtheria from diseased animals to man is again occupying the attention of the British daily press. This time it arose out of the death of a little girl who was thought by her mother to have contracted diphtheria from certain chickens which were kept in the house. The mother's view was supported by a medical man, who said that birds are subject to the germs of diphtheria and die of the disease. He had no doubt also that dogs and cats could have diphtheria, and he knew of instances of pigeons which had it.

The present writer has recently made an exhaustive critical analysis of the literature on this subject, and can state definitely that this bird, cat, and dog story is a pure myth. Diphtheria bacilli have been found on three occasions in cows (cases of Dean and Todd (1902),

Ashby (1906), and Henry (1920)), and by two authors (Cobbett (1900) and Minnett (1920)) in horses. No proved diphtheria bacilli have ever been found occurring spontaneously in cats, dogs, or fowls. In 1920 Simmons obtained, from two cats, bacilli resembling diphtheria bacilli in man, but differing in the fundamental respect that they fermented cane sugar, which human diphtheria bacilli do not.

The belief that cats are frequently capable of transmitting diphtheria arose in Great Britain largely out of work done by E. Klein for the Local Government Board in 1889 and 1890. He based his opinion on the existence of spontaneous diphtheria in cats on the fact that a very fatty condition was found in the kidneys, a lesion which he regarded as pathognomonic of the disease in this animal. Before Klein published this statement it was already well known (Gluge (1850), Handfield Jones (1853), and Beale (1869)) that all normal cats show this lesion—a fact confirmed by modern writers like Hansemann (1897), Fibiger (1901), and Mottram (1915–16). In an extensive inquiry in 1919–20, Savage was unable to find, nor could any one produce, a cat infected with diphtheria bacilli.

The doctrine of milk-borne diphtheria was also largely based on Klein's work (1890). He alleged that when cows are injected with cultures of diphtheria bacilli in the shoulder, these diphtheria bacilli appear in the milk and the animals suffer from an eruptive disease of the udders and teats. Dean and Todd (1902) traced a milk-borne epidemic of diphtheria to cows with scabs on the udders. They showed that the eruption was not due to diphtheria, and they regarded the diphtheria bacilli found in the udder as a superposed infection from the saliva of an infected milker. In 1920 Henry studied an epidemic of thirty-two cases. The disease was traced to milk. The dairy-maid was found to be suffering from cutaneous diphtheria, and from her the udder became affected, this in turn transferring the disease to the hands of the maid's father.

So far as is known, these are all the positive facts of the animal transmission of diphtheria to man. We may therefore assume that it is an event of exceeding rarity. With regard to birds there is no proved instance that these animals have ever transmitted the disease. So-called croup and diphtheritis in birds have nothing to do etiologically with human diphtheria. It is not necessary to assume an animal origin of an outbreak of diphtheria until all possible human sources in the immediate neighbourhood have been excluded. This can be done only by cultivations, and not by the pious opinions of mothers and medical men without experience in bacteriology. W. B.

Obituary.

Prof. E. Majewski.

THE late Prof. Erazm Majewski, the Polish naturalist, who died on November 15 last in Warsaw, was a scholar and pioneer worker of a type characteristic of the difficult and discouraging conditions in pre-War Poland—a country divided by three alien states, two of which forbade the use of the native language, even in the primary schools, excluded native teachers, and suppressed native culture.

Born in 1858, in the provincial town of Lublin, Prof. Majewski studied science at the University of Warsaw. In order to devote himself to research, to which he had felt attracted from earliest youth, he had first to gain a financial independence, for at that time there were no endowments, no academic positions, no possibilities of scientific publication for a Pole who wanted to work in his own language and for his own country. Prof. Majewski took up and developed an important branch of chemical industry and thus obtained a living at first, and afterwards what, for Polish conditions, might be considered a small fortune. With this he could not only find leisure for his own research, which soon became very strenuous and extensive, but he also was able to finance research and help a number of younger students.

Prof. Majewski's own activities were astoundingly multifarious: translations into Polish, popular expositions, manuals, monographs, scientific novels, treatises, and last, not least, solid original contributions, partly based on research in the laboratory and in the field. The subjects of his work were commensurately extensive: chemistry, botany and geology; later on, ethnography, prehistory and archæology; finally, in the last ten years of his life, economics, sociology, and history of civilisation. Perhaps the most lasting value will be retained by his archæological and prehistoric studies, through the impetus which he gave to excavation and collecting, through the foundation of an excellent periodical (*Swiatowit*), which he financed and edited himself, and through the formation of a large and valuable collection of Slavonic archæology, presented in 1921 to the Scientific Society of Warsaw.

All Prof. Majewski's work reveals a man of genius in the marvellous grasp of each problem touched upon, in the original and independent point of view, in the amazing power of study and assimilation. It shows, of course, also the defects of its qualities: such enormous output over a wide range is bound to entail a certain degree of dilettantism, many hasty generalisations, and a tendency to avoid all negative evidence. All the defects of the late Prof. Majewski's work, however, are due mainly to the unfavourable conditions under which he worked: absence of scientific organisation, of co-operation and of division of work, all of which leads to the unlimited pegging out of claims over the vast territory of science by an enterprising and independent mind, to lack of self-criticism, to an easy lapsing into over-ambitious schemes. The qualities which he possessed, on the other hand, are native and intrinsic to his own mind, and entitle us to hope that his country, which can produce such people as he under the most discouraging conditions, will, when its political and economic foundations are once more secure and its scientific work organised, be able to contribute its due share to the progress of science.

B. M.

Dr. Hartwig Franzen.

On February 14 the death occurred at Karlsruhe, Baden, of Dr. Hartwig Franzen, extraordinary professor of organic chemistry at the Technical High School.

Hartwig Franzen was born on March 21, 1878, at Nortorf, Holstein; he studied at Heidelberg, Berlin, and Copenhagen, graduating in 1901 at Heidelberg and becoming a private lecturer in chemistry at that university. His first work was published in collaboration with Th. Curtius, the discoverer of hydrazine and hydrazoic acid (azoimid), whose favourite pupil he was. In 1910 he became extraordinary professor and was called in 1912 to the Technical High School at Karlsruhe as subdirector of the organic chemistry institute. Franzen worked on gas analysis and embodied his results in his "Practicum," which was published in 1907. He also investigated the hydrazine compounds and problems in the chemistry of fermentation and the physiology of plants. Many of his publications deal with the constituents of green plants. Franzen was a well-known investigator and an efficient teacher. His early death leaves a great gap in the ranks of the younger German chemists, and his numerous friends and pupils will faithfully preserve his memory.

WE regret to announce the following deaths:

Mr. F. W. Harmer, for more than fifty years a fellow of the Geological Society and well-known for his studies of Pliocene mollusca, on April 24, aged eighty-seven.

Prof. G. D. Hinrichs, formerly professor of physical science in the University of Iowa and of chemistry at the St. Louis College of Pharmacy, aged eighty-six.

Sir Albert J. Hobson, pro-chancellor of the University of Sheffield and for twenty years a member of the council of the University, on April 20, aged sixty-one.

Prof. V. Th. Homén, Pippingsköldsche professor of applied physics in the University of Helsingfors, aged seventy-five.

Dr. A. Latham, physician and lecturer in medicine at St. George's Hospital, who was known for his work on pulmonary consumption, on April 13, aged fifty-six.

Prof. E. W. Morley, professor of chemistry at Western Reserve University from 1869 until 1906 and known for his part in the Michelson-Morley experiment to detect motion of bodies through the æther, aged eighty-five.

Sir John Watney, chairman of the Council of the City and Guilds of London Institute, on March 25, aged eighty-nine.

Mr. J. Wright, well-known for his work on Irish foraminifera and carboniferous fossils, on April 7, aged eighty-nine.

Current Topics and Events.

THE "Zoological Record," which for nearly sixty years has annually supplied zoologists with bibliographical references to the literature of their subject, and in particular has performed the task of recording the names of new genera and species introduced each year, is threatened with extinction. Although the responsibility for producing the Record was temporarily shared with the International Catalogue, which has ceased to exist, the credit for its publication, during recent years, has otherwise belonged exclusively to the Zoological Society, which has thus earned the gratitude of workers in all parts of the world. The decision of the council of the Society to cease publication, except on certain terms which are explained in another part of this issue, will be received with regret and consternation by a large number of investigators. It is urgently necessary that a combined effort should be made to save this invaluable serial, and those interested are invited to communicate with Sir Sidney Harmer, at the British Museum (Natural History). Suggestions will be welcomed, but it is hoped that many will be able to express their sympathy in a practical form, by undertaking to subscribe for the annual volumes or for the separate parts in which they are individually interested, or by giving assistance of an even more direct nature.

THE treatment of diabetes by the use of the extract of the pancreas known as "insulin" is now made more widely possible by the fact that it has been put upon the market by the British Drug Houses in conjunction with Messrs. Allen and Hanburys, Burroughs, Wellcome and Co., and Eli Lilly and Co. On account of the limited supply as yet available, the Medical Research Council has made certain recommendations to the Ministry of Health with regard to its economical use. The Minister has appointed the following committee to advise him on the subject: Sir George Newman, Dr. R. A. Bolam, Sir Walter Fletcher, Sir Humphry Rolleston, Dr. Alfred Salter, and Dr. McCleary. This committee, which can be addressed at the Ministry of Health, Whitehall, has recommended that insulin should be supplied only to hospitals and medical practitioners who have at their disposal means of determining the sugar content of the blood. Those to whom the preparation is supplied shall undertake to make observations of the changes in the amount of sugar in the blood in correlation with the dose of insulin given. It shall not be given where the symptoms can be controlled by moderate restriction of diet. It may, however, be given in coma, as an emergency treatment, or in preparation for a surgical operation. Detailed instructions for its use and for obviating the results of too large a dose are supplied by the makers with each sample.

A MEMBER of an Indian Provincial Legislative Council was reported recently to have demanded that the budget allotment for combating hookworm disease should be cut out because, as ninety per cent. of the people suffered from this serious disability, "it was a normal state of health and there was no meaning in spending money on investigation and prevention of the disease." The demand revealed a dangerous depth of ignorance, or, what is worse, a perversion of knowledge—for the speaker was an Indian doctor—which is only equalled by that of another member asking not long ago what steps a Provincial Government proposed to take to diminish the deaths due to lightning! Unfortunately, the Retrenchment Com-

mittee has recently recommended decentralisation of medical research in India, with consequent dependence of all grants for its support being voted annually by the large Indian Council majorities. The qualifications for such serious responsibility can be gauged by the above examples, and they are combined with administration by an Indian Minister who is very unlikely to look beyond his own province and race for research workers. Moreover, the original grant of five lakhs of rupees (33,000*l.*) a year for medical research was cut down to 3½ lakhs during the War, and is now recommended to be abolished. In its place the 33 lakhs accumulated by the Indian Research Fund Association during the War, and ear-marked for a new research laboratory in Delhi, is to be capitalised to bring in about two lakhs a year for the full support of the bacteriological department, which is to be deprived of twelve of its officers—more than one-third of the total number—the whole savings from this small department being disproportionally great as compared with many far less valuable and life-saving forms of expenditure. The future of medical research in India will be dark indeed if such large reductions in finance and personnel are effected, and still more so if the remaining funds are to be placed at the mercy every year of the large Indian majorities on all the Provincial Councils, few of whom have had the slightest scientific knowledge or training.

THE first congress of Polish Chemists and Physicists met in Warsaw on April 3. With a total membership of about 850, this meeting has taken a high place among recent Polish scientific congresses, and the organising committee is to be congratulated upon the brilliant success achieved. A large gathering of scientific and industrial chemists and physicists, together with representatives of the Government, the Municipality of Warsaw, and of various societies and corporations, filled the Great Hall of the Technical High School of Warsaw on April 4, when the meeting was welcomed by Dr. Mikulowski Pomorski (Minister of National Education), and short scientific addresses were delivered by Prof. Ladislas Natanson (Rector of the Jagellonian University of Cracow), and by Profs. Marchlewski, Bialobrzeski, and Moscicki. The scientific proceedings of the sections were full of interest; about 120 papers were read in various chemical sections and about 36 in the section of physics; there were many communications showing serious work and real progress. Particularly interesting, in the section of physics, were communications by Profs. Pienkowski, Zakrzewski, Wolfke, and Reczynski on experimental investigations in progress in various University laboratories in Poland. The meeting concluded on April 6 with an address delivered by Prof. Tolloczko, and the usual votes of thanks. The hearty reception accorded to scientific men coming from all parts of Poland was much commented upon by those who attended this very successful meeting.

THE first conversazione of the Royal Society this year will be held at the Society's rooms, Burlington House, on Wednesday, May 16.

THE *Times* announces that the Anthropological-Geographical Society of Stockholm has conferred the Anders Retzius Medal in gold upon Sir Aurel Stein for his archæological research in Central Asia.

THE twenty-ninth James Forrest lecture of the Institution of Civil Engineers will be delivered on May 4 by Sir Richard Glazebrook, who will take as his subject "The Interdependence of Abstract Science and Engineering."

DR. H. H. DALE will deliver two Oliver-Sharpey lectures at the Royal College of Physicians of London on May 1 and 3, at 5 o'clock, taking as his subject "The Activity of the Capillary Blood-vessels, and its Relation to certain Forms of Toxæmia."

THE Adolph von Baeyer Memorial lecture will be delivered before the Chemical Society by Prof. W. H. Perkin, in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Thursday, May 10, at 8 P.M.

THE Secretary for Mines has appointed the following to be additional members of the Safety in Mines Research Board: Prof. W. S. Boulton, Prof. S. M. Dixon, Dr. J. S. Haldane, Prof. C. H. Lees, and Prof. J. F. Thorpe.

THE Chemical Society Research Fund Committee will meet early in June. Applications for grants should be made on forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, Piccadilly, W.1, and must be lodged with the Assistant Secretary by June 1.

APPLICATIONS for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales during the academic year beginning on October 1 next should reach the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, S.W.1, by, at latest, May 15. The applications must be made upon form A. 230/1, copies of which can be obtained from the Secretary to the Ministry.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for a limited number of research scholarships in agricultural and veterinary science, tenable for three years and each of the annual value of 200*l.* The latest date for the receipt of applications, which must be made upon a prescribed form, is July 15. The form and particulars concerning the conditions of the scholarships are obtainable from the Secretary, Ministry of Agriculture and Fisheries, Whitehall Place, S.W.1.

AN election of not more than six junior Beit Memorial fellows for medical research will take place in July next, and the persons elected will be required to begin work on October 1. Each fellowship is of the annual value of 350*l.*, and the usual tenure is three years. The latest date for the receipt of applications is June 1, or, in the case of candidates giving residents abroad as referees, May 15. Forms of application and all information may be obtained by letter only addressed to Sir J. K. Fowler, Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

DR. EDWARD P. HYDE, who organised the Nela Research Laboratories in 1908, and for the past few years has occupied the position of director of research of the National Lamp Works of the General Electric Co., Cleveland, has tendered his resignation, to take effect on June 30. Dr. Hyde, who has been active in scientific and technical affairs for a number of years, has decided to take a prolonged rest abroad. He will temporarily discontinue many of his activities in scientific and engineering societies, but will retain the office of president of the International Commission on Illumination until its plenary meeting, to be held in the United States in 1924.

IN connexion with Dr. Simpson's Royal Institution discourse on "The Water in the Atmosphere," published in NATURE of April 14, Prof. A. W. Bickerton writes to suggest an alternative formation for hailstones which have the form of cones mounted on hemispherical bases. It is suggested that these may be formed by the freezing of raindrops which solidify first on the outside, then, as the core freezes, the expansive pressure bursts the spheres along the lines of minimum resistance, these being the lines of a pentagonal dodecahedron. The difficulty of this explanation is that soft hail, to which reference was made by Dr. Simpson, forms above the region where raindrops are met with. Also the "stones" of soft hail are frequently so large that the mass of twelve of them would be much greater than the mass of the largest possible raindrop — which has a diameter of less than half a centimetre.

THE Gifford Lectures delivered in 1922 by Prof. C. Lloyd Morgan will shortly be published by Messrs. Williams and Norgate under the title of "Emergent Evolution." Among the chapter headings are the following :—emergence, mental and non-mental, relatedness, reference, memory, images, towards reality, vision and contact, relativity, causation and causality, and evolutionary naturalism.

MESSRS. SOTHERAN'S Catalogue of Science and Technology is always of bibliographic interest and value, being carefully classified, and containing informative annotations to many rare volumes offered for sale by the publishers of the catalogue. The latest part is No. 783, dealing with mathematics. It should be seen by all who take an interest in the subject. The catalogue is obtainable from H. Sotheran and Co., 140 Strand, W.C.2.

Our Astronomical Column.

THE PLANET JUPITER.—This planet will arrive at opposition to the sun on May 5, when its distance from the earth will be about 410 millions of miles. It is now visible during the whole night, and is favourably situated for telescopic examination. The Great Red Spot in the southern hemisphere remains faintly visible, and a slight increase in its rotation period has occurred in the last few years. Its present longitude is 228°, so that it precedes the zero meridian of System II. by about 3 h. 38 m. Observations of the transits of this marking will be valuable, and may be witnessed at about the following times :—

	h.	m.			h.	m.	
April 29.	8	47	G.M.T.	May 8.	11	6	G.M.T.
May 1.	10	21	,,	,, 11.	8	37	,,
,, 3.	11	59	,,	,, 13.	10	15	,,
,, 6.	9	28	,,	,, 18.	9	22	,,

The extensive dusky marking, known as the south tropical disturbance, is now in contact with the following end of the Great Red Spot, and it will be interesting to watch this object, as it passes the Red Spot in ensuing months.

From recent observations by Mr. F. Sargent of the Durham University Observatory, it appears that the rotation period of the south edge of the South Equatorial belt of Jupiter shows an abnormal period of $9^h\ 52^m\ 37^s$. This latitude on Jupiter falls between the two well-known currents, on which Systems I. and II. were based, the periods being $9^h\ 50^m\ 30^s$ and $9^h\ 55^m\ 40{\cdot}6^s$ (Nautical Almanac, 1923, p. 568-71).

The unusual time of rotation was derived from a mean of three markings, but the observations extended over too short an interval to obtain exact results. There is no doubt, however, that there is an intermediate current between that in which the Great Red Spot is situated and the equatorial markings, and it will be important to follow the objects seen by Mr. Sargent which on March 29 were in longitudes from 309·7° to 325·1° (System I.).

SPECTRA OF THREE O-TYPE STARS.—Dr. H. H. Plaskett contributes to the Publications of the Dominion Astrophysical Observatory (vol. 1, No. 30) an important research on the spectra of three O-type stars. These stars show enhanced line spectra which can only be reproduced terrestrially under extreme conditions of excitation. Their spectra thus afford an opportunity for testing theories on the origin of spectra and for ascertaining some of the physical conditions in stellar atmospheres. The stars in question were 10 Lacertæ (Oe 5), 9 Sagittæ (Oe 5) and B.D. 35° 3930 N (Oe) and their spectra were secured with the universal spectroscope attached to the 72-inch reflector using one-, two- and three-prism dispersion. Dr. Plaskett first points out that if the Pickering lines (ζ Puppis) are due to enhanced helium, Bohr's theory predicts the existence of enhanced helium components about 2Å to the violet of the hydrogen lines. He then gives his evidence for showing that those predicted components are present in his spectra, which demonstrates that the Pickering lines and λ 4686 are due to enhanced helium.

In two of the stars Dr. Plaskett employs the mean wave-lengths of the enhanced helium lines for the determination of the value of the Rydberg constant N2 for helium, and deduces the values of Planck's constant and the mass and charge of the electron. Those values he compares with recomputed values from Paschen's value of N2 and with results from other methods of determination. He deduces the temperatures of the O-type stars under discussion and gives the following values : 9 Sagittæ, 18,500° K ; 10 Lacertæ, 15,000° K ; and B.D. 35° 3930 N, 22,000° K. He finally suggests a modification of the Harvard Classification of the O-type stars as follows :

Class Oo, Pickering lines disappeared ; Class O5, (B.D. 35° 3930 N) ordinary helium disappeared ; Class O7 (9 Sagittæ) Mg +, 4481 missing; Class O9, Si III +, pair 4552, 4567, on the point of appearing.

Research Items.

EXCAVATIONS AT ANCIENT CARTHAGE.—A correspondent writing in the *Times* of April 9 describes the result of excavations on the site of ancient Carthage conducted by a party of Americans working in co-operation with French archæologists. Their work is timely, as the site of this city is in danger of becoming a modern suburb of Tunis. Within the city itself the remains of two sanctuaries and the potters' quarter have yielded some sculptured stones and numerous specimens of pottery. But the most important discovery is an underground corridor through which a supply of water passed, and some rock-cut tombs, containing statues, two on recumbent stone coffins of Greek work, and others showing that the Carthaginians were dependent for their art on Greece and Egypt. It is hoped that further exploration will throw light on the Roman buildings and North African architecture during the Christian period.

CLASH OF IDEALS IN MODERN INDIA.—The Earl of Ronaldshay, Governor of Bengal, 1917–22, delivered an interesting address before the Indian Section of the Royal Society of Arts, which is printed in the Society's Journal (vol. lxxi., No. 3, 665), on the situation in India. The motive force of the native movement is "fear lest before the triumphant assertiveness of Western civilisation all that is essentially and distinctively Indian is doomed to perish and utterly to disappear." As regards education, there is dissatisfaction with the present system, but it is not easy to discover what it is that Indians desire to see taking its place. There is an emphatic demand for vocational or practical instruction—they object to the present courses as displaying a Western bias; the demand in Bengal for medical training is clamorous and widespread, "and many Indians who are far from being hostile to the British connexion desire to see a more distinctly Indian orientation given to the education imparted to their people." The address, which deserves attention, takes, on the whole, an optimistic view of the present situation.

PSYCHOLOGY AND CRIMINAL RESPONSIBILITY.—In *Psyche* (vol. iii., No. 2) Dr. W. Brown discusses the attitude of modern psychology to responsibility. He shows that there is a tendency for those who understand incompletely the aims of modern psychology, to believe that a general spread of its doctrines will result in a weakening of the sense of moral responsibility. He discusses the legal definition of responsibility and describes cases where a crime of violence may be committed for which the person cannot be held responsible. The psychologist, as such, is concerned with the problem of studying the causes in the history of the person which have led to the act, and the contribution of recent work is in the direction of tracing the influence of the acts and phantasies of infancy and childhood; it appears not infrequently that the people answerable for the victim's upbringing were really responsible. Modern psychology does not contest the reality of moral responsibility. While it holds the view that criminals suffering from certain forms of mental disease are less fully responsible than are normal people, it does not countenance the view that all criminals suffer from mental illness, nor that mental illness is an invariably sufficient excuse for crime.

THE ALPHABET USED IN WRITING MALAY.—There is no record of the Malay language having been written until the Arabs reached Indonesia, the oldest existing documents being written in the Arabic character, which is still largely used. After the Arabs came the Portuguese, Dutch, and English, and each nation adopted its own system. It has been felt for a long time that it would be a convenience if a uniform system of spelling were adopted. Hitherto the choice has lain between Arabic characters and the Dutch or English spelling, none of which are quite satisfactory. Mr. C. H. Pownall in a pamphlet entitled "The Writing of Malay" (Cambridge, W. Haffer and Sons, Ltd.) suggests that the system known as "Peetickay," advocated by Dr. W. Perrett in a book issued by the same publishers in 1920, should be adopted. It possesses the special advantage that those who suffer from writer's cramp find it a great relief, as the pen is more frequently raised from the paper than in ordinary writing. Mr. Pownall regards this system as preferable to the symbols used by the International Phonetic Association: but it does not seem probable that a conservative oriental race will be inclined to adopt a new system instead of the systems to which they are accustomed. In the end, in spite of certain difficulties, English will hold the field.

THE LAWS OF VISION AND THE TECHNIQUE OF ART.—In his treatise on landscape painting, Birge Harrison shows that a picture is most artistic when it reproduces our retinal impressions, and his theme has been taken up and developed by Messrs. A. Ames and C. A. Proctor and Miss Blanche Ames in an interesting paper published under the auspices of the Rumford Fund in the February issue of the Proceedings of the American Academy. The retinal picture is less distinct at the edges than at the centre and is distorted in the "barrel" manner, while the retina itself is more sensitive to blue near the edge than at the centre. When a photograph of a landscape or building taken with a camera having a lens with the same properties as the eye is compared with one taken with a corrected lens, that taken with the artificial eye produces the more artistic effect. On examining a number of pictures by distinguished artists, the authors have found evidence of the use—conscious or unconscious—of the technique suggested by these laws of vision by da Vinci, Rembrandt, Israels, Millet, Turner, Whistler, De Hoogh, and others, but only by one living artist—Orpen. The authors urge that the retinal picture should be made the basis of the technique of art.

CLASSIFICATION OF CIRRUS CLOUDS.—In *Geografiska annaler*, 1922, 3-4, Mr. H. H. Hildebrandsson has a short paper in which he discusses an international terminology for the various kinds of cirrus clouds. After full consideration of the forms of cirrus described by L. Besson, C. J. R. Cave, A. W. Clayden, C. Ley, J. Loisel, l'Abbé Maze, H. Osthoff, and J. Vincent, all the classifications of whom are summarised, Mr. Hildebrandsson proposes seven main types. Some of these are rare and none is common in its typical form, but they serve as a basis of a classification to which all cirrus can be referred. The seven types, each of which is briefly described and in many cases illustrated, are uncinus or caudatus, vertebratus, pennatus, filosus, confertus, floccosus, and nebulus. The names have the merit of being indicative of each type, and are easily remembered. The classification certainly seems to be sounder than some former ones which recognised a dozen or more main types.

CLIMATOLOGICAL NORMALS FOR EGYPT AND THE SUDAN.—The Physical Department of the Ministry of Public Works, Egypt, has issued a book of normals

which comprises 63 stations, and in addition to the Egyptian and Sudanese stations, it includes seven stations in Cyprus, one in Crete, and one in Abyssinia. Many of the normals cover a period of 20 years. Normals for rainfall are given for 76 stations, for the total number of years for which trustworthy records are available. It is said not to be uncommon, especially in the Sudan, for the relative humidities to fall below 10 or even 5 per cent. Wind force given throughout is stated to be in terms of numbers on the Beaufort scale. The scale is given as 0–10, but Beaufort scale should be 0–12. The equivalents in miles per hour given for the scale 0–10 is in fair agreement with the Beaufort values 0–10 given by the British Meteorological Office. The percentage frequency of wind direction is given for most stations. Most of the Egyptian stations have single louvred screens; this seems scarcely satisfactory, especially for a hot country. Monthly maps are given for isobars and prevailing winds, for air isotherms, and for rainfall. The tables of normals are of great value to the world's meteorology. The absolutely highest temperature on a single day at many stations exceeds 120° F. and in places even touches 130° F. On the coldest day in winter frost is exceptional in the shade to the south of 20° N. Rainfall for a single day is occasionally more than the average total fall for the month; there are two instances of 11 inches and more in the 24 hours—at Alexandria in December 1888 and Tombé in the Sudan in July 1914. A rainfall map intended as a frontispiece will be issued separately.

PEAT IN THE UNITED STATES.—Though peat is still looked on with hesitation as a source of industrial fuel in the near future, every national geological survey is attracted by the numerous schemes for its exploitation. That of the United States has issued Bulletin 728, on "The occurrence and uses of Peat in the United States," by E. K. Soper and C. C. Osborn (1922). The maps record very considerable deposits in the regions of more temperate climate, as in Minnesota towards the Canadian border. It is pointed out that, contrary to popular belief, the Mississippi basin is poor in peat, owing to the high temperature, which accelerates the decay of vegetation, and the frequent floods, which deposit sheets of alluvium. Some of the plates illustrating the infilling of basins of various types introduce unusual scenes, such as the Dismal Swamp, with its decaying forest, in the Virginian coastal plain. When we come to the treatment of peatlands for raising crops, we find that the customary advice is given, to clear away the upper peat as much as possible, to drain thoroughly, and to add materials that will provide the land with something like a reasonable soil. The case is familiar to us through agriculture in the English fenlands. The Bulletin forms a good handbook for the appreciation of lowland peat-deposits by the student.

GENETICS OF PRODUCTIVITY.—In a study of productiveness in apple trees, Sax and Gowen (Bull. 305, Maine Agric. Expt. Sta.) show that this quality is closely associated with habit of growth, although soil differences in an orchard also play a part. They also show (Bull. 307) that many commercial varieties of apples are self-sterile and that insect visits are essential for the setting of fruit. They recommend the interplanting of different varieties which are inter-fertile and flower at the same time. In two other papers (Bulls. 301 and 306) on milk production in Holstein-Friesian cattle, a further study is made of the transmitting powers of sires for milk production, and of the relative merits of a 7-day or a 365-day test for the relation between milk yield and percentage of butter-fat. That the daughters of different sires inherit differences in their milk production is well known. But pedigree results show that the cattle breeder's principle that "like begets like" is not a sufficient one to follow in breeding for milk production.

MOULDS ON MEAT IN COLD STORAGE.—On behalf of the Food Investigation Board, F. T. Brooks and M. N. Kidd recently published, in Special Report No. 6 of the Board (1921), an account of the "black spot" produced upon meat in cold storage by the activity of moulds. In this report it was demonstrated that the moulds responsible for the discoloration could grow and reproduce, although the meat was kept at −6° C. F. T. Brooks and C. C. Hansford have now published the more interesting mycological results of this valuable piece of applied research in the Transactions of the British Mycological Society, vol. 8, Part III., pp. 113-142, 1923. They conclude that *Cladosporium herbarum* is the species responsible for all the cases of "black spot" on meat they have observed, and that *Hormodendron cladosporiodes* is identical with it. This Cladosporium appears to occur very generally on vegetable refuse as well as on meat, and to be very variable in habit, so that a careful control of its structure and growth on a wide range of culture media is necessary for its identification. Many of its forms appear to have been described as species. Among the other moulds growing on cold stored meat two new species, *Sporotrichum carnis* and *Torula botryoides*, have been isolated; while on one occasion a new genus turned up in a woolly patch of mould present on a consignment of skinned Australian rabbits. In view of the laboratory from which the present work is issued, it is appropriate that the authors have named the new genus Wardomyces in memory of the late Prof. Marshall Ward.

THE SPREAD OF RUSTS UPON CEREALS.—With work proceeding for the new Ph.D. degree at many British Universities, we shall probably have many theses published in which essentially British problems are materially elucidated by overseas investigators. Certainly Karm Chand Mehta, now professor of botany at Agra College, India, as a result of his work at Cambridge under the direction of Mr. F. T. Brooks, has given us a most valuable study of the methods by which cereals are attacked year after year by the various species of the rusts (now published in the Trans. Brit. Mycological Soc., vol. 8, Part III., pp. 142-176, 1923). The rusts are quite unable to grow as saprophytes, hence there is great difficulty in their continued maintenance in pure culture, and much discussion as to the method by which these fungi maintain themselves through the winter when their normal host plant is harvested in the autumn. These parasites were some of the first microscopic forms in which a well-marked life cycle was traced with essential stages in two separate host species, often plants of widely different nature, and in the case of the black rust of wheat, *Puccinia graminis* Pers., the present paper supplies further evidence for the truth of an oft-contested thesis that the wheat plants may be infected from the accidial stage upon the winter host, the wild barberry. In the case of the other rusts of wheat, brown rust, *P. triticina* Erikss., and yellow rust, *P. glumarum* Erikss. and Heun, the observations and experiments here recorded show the significance of the self-sown seedlings of the wheat left in the ground after the harvest; upon these the fungus persists and the uredospores formed upon them are the main source of infection of the new crop. This paper, as some earlier classic papers from the Cambridge laboratory, is fundamentally

opposed to the point of view of the great Scandinavian mycologist Eriksson, who has assumed that the fungus must persist through the life-cycle of the host plant as an undetectable protoplasmic contamination, "mycoplasm," intermingled with its own living substance.

ARTESIAN WATER IN AUSTRALIA.—In the report for 1921 of the Director of Mines and Government Geologist for South Australia, there is included a useful map of the principal artesian basins of Australia, made in connexion with the interstate conference on artesian water which met at Adelaide in September 1921. The map is of special interest in showing the isopotential lines or the heights above sea-level to which the water will rise. These lines have been accurately determined in many parts of the great artesian basin, especially in New South Wales and Queensland. They are less certain in parts of South Australia, but they are sufficiently accurate to show the absence of any concealed south-westerly outlet. The basin as a whole has marginal intake beds surrounding it. Fragmental isopotential lines for the Murray river basin have been embodied in the map. The scale of the map is too small to allow detail in the case of the basins of Willochra valley, Port Pirie, Cowell, and Adelaide plains. There is a lack of information in the case of the Eucla basin, but from the variable salinity of the water it would seem to be derived from more than one source in the sandy desert.

GENERALISED OPTICAL LAW.—Part 1 of volume 24 of the Transactions of the Optical Society contains the generalised optical law communicated by Mr. T. Smith to the Society in December last and called by him the optical cosine law. It includes as special cases the law of refraction, the coma sine law, the axial displacement and other exact laws of optical instruments, and runs thus: If I is the angle of inclination of a ray to a chosen fixed direction in the object space and I′ the inclination of the emergent ray to a chosen fixed direction in the image space, then the rays for which $\cos I = p \cos I' + q$ where p and q are constant touch caustics S in the object and S′ in the image space, and if S be displaced a small distance s along the fixed direction in the object space to S_1 the image caustic S′ will move along the fixed direction in the image space through a distance s', where $n's' = nsp$ and $n\ n'$ are the refractive indices of the object and image media. The application of this generalised law to the construction of a telescope aplanatic at all magnifications is given as an illustration.

WIND STEADINESS IN THE UPPER AIR.—To the March number of the *Meteorological Magazine* Mr. H. Harries contributes some curious facts about the flights of toy balloons in "races" organised by Major MacLulich at Brighton during the summer of 1922. On August 23 two balloons were liberated together, and next morning they descended in the little village of Marcel par Vitrey, Haute Saône, having travelled in company S. 51° E., 295 miles. On September 21 two others started together in a dead calm, made a perpendicular ascent of about 2000 feet, and disappeared in a cloud. Within 12 hours both dropped in the streets of Cassel, Germany, the course and distance being N. 85° E., 365 miles, at a rate of 30 miles an hour. Numerous balloons were sent off on September 9, under well-marked anticyclonic north wind conditions. The cards of 43 of them were recovered within a small area in the north of France, nearly all having followed a course between S. 2° E. and S. 5° E. They had attained an altitude where the wind was of gale force, one of the balloons, found 2½ hours after its despatch, having covered 108 miles, at a rate exceeding 43 miles an hour. Of a different character were the flights of September 13, the balloons being liberated in front of a cyclone approaching Brighton from the midland counties. The cards of 20 were returned, and of these 15 were drawn into the cyclone and descended in various places in Kent, Essex, Suffolk, Bucks, and Berks—the greater part of the circuit of the cyclone. The other five, apparently attaining a higher altitude, were caught in a westerly, veering north-westerly, current, which carried them to north-eastern France. One dropped at St. Ouen, Paris, 226 miles distant from another despatched at the same time, which descended at Thatcham Park, Stowe, Bucks.

ACTIVE HYDROGEN AND CHLORINE.—In the Proceedings of the Science Association, Maharajah's College, Vizianagram, published in December 1922, Mr. Y. Venkataramaiah gives an account of some further experiments he has made on active hydrogen. Hydrogen gas obtained by the action of heat, and of water, on sodium hydride, as well as hydrogen gas which had bubbled through molten sodium, reacted with sulphur in the cold, and therefore contained active hydrogen. Similar results were obtained with potassium and calcium. Other methods for the activation of hydrogen (burning oxygen in hydrogen, surface combustion of hydrogen and oxygen on platinum, high tension arc in hydrogen, high temperature arc in hydrogen, and the passage of hydrogen through heated platinum and palladium) are described in further papers. In the same journal Mr. Venkataramaiah describes the activation of chlorine, prepared by heating gold chloride and dried with phosphorus pentoxide, by the silent discharge, by electric discharges in the gas, by ultra-violet light, and by the heat of an electric arc. The gas combines with ozone to form Cl_2O, with sulphur to form S_2Cl_2, and reacts with benzene in the dark to form $C_6H_6Cl_6$.

THE HERBERT PENDULUM HARDNESS TESTER.—Two points to be looked for in a "hardness" tester are simplicity of operation and results independent of the mass and thickness of the specimen. These are among the desirable features of a new instrument made by Messrs. Edward G. Herbert, Ltd., of Manchester, others being portability and the immunity of the specimen from damage due to testing. Thin strip, case-carburised steels, minerals, and glazes on pottery thus come within the scope of the machine. The apparatus consists of an arched casting weighing 4 kg., surmounted by a curved spirit-level graduated from 0 to 100. It is supported on the specimen by a 1 mm. ball fixed beneath the centre of the arch. With the standard setting the instrument has its centre of gravity 0·1 mm. below the centre of the ball, and is thus free to oscillate. "Scale tests" are made by placing this rocker normally on the specimen and tilting it until the level-bubble reads 0. On releasing the instrument the graduation to which the bubble floats is the "Scale Hardness Number" (*e.g.* glass 97, mild steel 30). The recommended "Time tests" are made by causing the "pendulum" to oscillate and noting with a stop-watch the time for ten swings. Strange to say, while mild steel requires 20 seconds, the "Time Hardness Number" of glass is 100 seconds. Both tests, then, depend upon the degree of indentation of the specimen, and a time factor appears to be involved. There is good agreement between successive determinations. While the instrument detects "strain-hardness," it does not appear to indicate relative machining properties. The high ranges of the time hardness scale may be opened out by raising the centre of gravity of the "pendulum," and altogether the system presents many important possibilities.

The "Zoological Record."

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 bibliographical guide to zoological literature being published in the whole world. In the annual report which the Council of the Zoological Society will lay before the forthcoming annual general meeting it is recommended that the Society shall not undertake the printing of any further volumes after the issue of the one in hand unless it receives substantial assistance towards meeting the cost. It is estimated that the cost of preparation and printing is 1900*l.*, towards which about 800*l.* is received from sales and subscriptions, leaving a net cost of 1100*l.*

With the object of ascertaining the views of other societies interested in scientific zoology on the question, a meeting of representatives was held in the Board Room of the Natural History Museum on April 16. In the absence of Sir Sidney Harmer, the director, owing to a family bereavement, the chair was taken by Lord Rothschild, a Trustee of the Museum and himself an eminent zoologist. Among the institutions and societies represented were the following: Linnean Society, Geological Society, Marine Biological Association of the United Kingdom, Imperial Bureau of Entomology, British Ornithologists' Union, British Ornithologists' Club, Royal Society of Tropical Medicine and Hygiene, Wellcome Bureau of Scientific Research, Malacological Society, Conchological Society, Challenger Society, Entomological Society of London. Letters urging the need for the "Zoological Record" were received from representatives of the Tropical Diseases Bureau, Liverpool School of Tropical Medicine, and the Universities of Cambridge, Durham, Birmingham, and Wales. The meeting was unanimously agreed as to the imperative need for the continuance of the Record, and authorised Sir Sidney Harmer to form a committee of those interested to confer with the Zoological Society as to the arrangements for carrying on the work.

In response to a question as to the attitude of the Trustees of the British Museum, Lord Rothschild stated that they had ordered the following statement to be sent to the Zoological Society for use in support of its appeal for assistance:

"The Trustees of the British Museum recognise the great value of the services rendered to science by the Zoological Society, which has for some years produced the annual volumes of the 'Zoological Record.' The indexing, year by year, of the names of newly-described genera and species, and of alterations in the names of others, may be regarded as an absolutely essential adjunct to work in this science. Although primarily of importance to systematists, the establishment of a correct nomenclature and the recording of new names are quite as necessary to workers in other branches of zoology, who are ultimately dependent on the systematists for the discrimination of the species with which they deal. With the accumulation of an enormous body of new facts, increasing in amount each year and much of it hidden away in the pages of publications which are difficult of access, the study of zoology is peculiarly dependent on having the record kept complete and up-to-date. The work of future naturalists would become almost impossible if each investigator had to make for himself a complete survey of the literature of his subject, published during many years without being indexed. The Trustees are accordingly of opinion that the continued publication of the 'Zoological Record' is indispensable to the progress of zoology. They have heard with regret that the Council of the Zoological Society is unable to undertake the sole financial responsibility for the appearance of the annual volume, and they have no hesitation in expressing their conviction that in these circumstances a strong effort should be made to obtain contributions from scientific societies and other bodies interested, with the view of relieving the Zoological Society of a part of the burden which it is no longer willing to carry unaided."

Agricultural Progress in India.

THE steady advance in the progress of scientific agriculture in India is reflected in a recent number of the *Agricultural Journal for India* (xvii., part vi.), in which a variety of experimental work is reported. D. R. Sethi describes successful attempts to reclaim large tracts of the desert area of the Kapurthala State, illustrated by striking photographs. Since 1918 about 100 acres of the worst land in the district have been levelled and provided with an ample supply of irrigation water, free from alkali salts, by means of a large tube well equipped with power-driven machinery. The loose sandy soil was rendered more tenacious by green manuring with sann-hemp, which decays in about a fortnight after ploughing in and has a most marked action in binding the sand together, further improvement being effected by the introduction of clay carted from the low-lands. Good crops of maize, cotton, wheat, sugar-cane, cow-peas and other leguminous crops are now being grown on the land, and it is hoped to be able to render such reclamation an economic proposition.

As the relative value of nitrogenous organic manures depends largely upon their nitrifiability, F. J. Plymen and D. V. Bal have tested a number of these on various typical soils of the Central Provinces and Behar, under varying conditions of climate and cultivation. The nitrogen of castor cake appears to be quickly available in most soils, the others following in decreasing order of availability. Ground nut cake is exceptional in that it decomposes slowly in most soils, but very rapidly and effectively in black cotton soil. The nitrifying power of typical rice soil, where the cultivation is of an anaerobic or semi-anaerobic nature during a great part of the year, is much less than that of soils subject to open cultivation.

The phosphatic manuring of rice soil has received attention from M. R. Ramaswami Sivan in pot and field experiments with Trichinopoly phosphatic nodule. This mineral contains too much lime, iron, and alumina to be manufactured economically into superphosphate, but it appears to be a suitable manure for paddy lands when applied with decomposing organic matter. In pot cultures with rice the phosphate alone was ineffective, but the addition of green manure brought the phosphate into action and resulted in a very considerable increase in crop. Nitrogen, as sulphate of ammonia, was a less efficient agent in rendering the phosphate available. The residual effect of this mineral phosphate seems to be considerable, but this point is still under investigation.

The hydrogen-ion concentrations of some Indian soils and plant juices have been determined by W. R. G. Atkins (Bull. 136, Agricultural Research Institute, Pusa), who suggests that the method may be useful to agriculture in various ways, as, for example, to delimit the degrees of soil acidity or alkalinity within which it is possible to grow certain crops, and to determine the lime requirements of particular soils. The acidity of some sandy Assam soils is suggested as the cause of their high content of available phosphate, which is beneficial to indigo and other crops. The reaction even of highly calcareous soils may be somewhat modified by manurial treatment, the use of such manures as sulphate of ammonia or potash rendering the soils slightly less alkaline, the reduction being about P_H 0·4. A further reduction takes place in waterlogged soil, owing to the accumulation of carbonic acid. The value of gypsum on black alkali lands is attributed to the fact that calcium sulphate will, by precipitation of calcium carbonate, reduce the alkalinity of a sodium carbonate solution from P_H 10 or less to P_H 8, the latter being a limit suitable for plant life, whereas the former is not.

Fact and Phantasy in Industrial Science.[1]

THE title of the lecture is intended to add to the obvious meaning of "industrial science" the complementary idea of a discipline or school of philosophy, and an interpretation under which the antithesis conveyed in the current expression "pure and applied science" is divested of any unreality. In regard to accumulation of exact knowledge of phenomena, no distinction of method or object is evident. "Pure science," however, is ideal in a sense which seldom characterises industrial research or scientific development of production.

The cellulose industries represent a vast accumulation of exact knowledge and a formidable array of statistical evaluation of fundamental matters of accepted fact. This tends to eliminate phantasy and imagination from the investigation of the primary routine processes of these industries, whereas these faculties have full play in the secondary arts of decorative treatment, *e.g.* in weaving design, bleaching and finishing, dyeing and printing: on the other hand, science has contributed new products, *e.g.* mercerised cottons, and the artificial (cellulose) silks, and attendant progressive extensions and developments, both artistic and scientific. Systematic scientific study of cotton, as an organic structure, as a colloidal complex with specifically characteristic hydration capacity, and as a chemical individual, is opening a vista of new developments of the primary textile industries.

Moreover, industrial research in this section adopts the unit cotton hair, as the determining factor of the industry, which is a radical change of the basis of accepted fact, from the empirical to the scientific. Similarly in the papermaking industry, current research concerns itself with units of minute dimensions, and the phenomena of the unseen and subsensible order. This trend of research again involves the faculties of phantasy and its more disciplined form of imagination.

The future of creative or constructive development of the cellulose industry would appear to be bound up with the application of physical and biological method: the former in investigating the properties of cellulose as such, and its actions and reactions in relation to light, heat and electricity; the latter in investigating the conditions of origin of cellulose structures, the natural history of bacterial resolutions, and the formation of humus, peat, lignite and coal. This general sketch of the matter of the lecture was developed by specimens and demonstrations.

[1] Abstract of a discourse delivered at the Royal Institution on Friday, February 2, by Mr. C. F. Cross, F.R.S.

Depth of Earthquake Foci.

THE question of the depth of earthquake foci is attracting considerable attention among seismologists, and forms the subject of several recent papers (Mon. Not. R.A.S., Geoph. Sup., vol. i., 1923, pp. 15-22, 22-31, and 50-55). In the first of these Dr. Dorothy Wrinch and Dr. H. Jeffreys consider the seismic waves from the Oppau explosion of September 21, 1921, which were registered at five observatories on the Continent at distances ranging from 110 to 365 km. from Oppau. Using the method of least squares, they find that the velocities of the P and S waves (first and second preliminary tremors) are respectively 5·4 and 3·15 km. per sec. These values, which are of course those for the superficial sedimentary layer, are much less than those determined from observations of earthquake waves (7·1 and 4·0 km. per sec.) for the upper layers.

A more important earthquake with a superficial origin is the Pamir earthquake of February 18, 1911, which, as Prince Galitzin suggested and Dr. Jeffreys has shown, was the result of the fall of a great landslip. This earthquake was recorded at seismological stations all over the world. Dr. Jeffreys compares the times of arrival of the P and S waves at various distances from the origin with those given by the standard tables. The latter represent the average of a large number of earthquakes, the foci of which were situated at various, though unknown, depths, but none of which was on the surface. Now, if the latter depths were great, as suggested by the late Dr. G. W. Walker, there should be considerable differences between the observed times for the Pamir earthquake and those given by the tables. From the absence of any such differences, Dr. Jeffreys concludes that the foci of the earthquakes on which our tables are based were not at depths greater than 120 km.

In the third paper, Prof. Turner supplements a former note (see NATURE, vol. 110, p. 55). Observations on the angle of emergence of earthquake waves at Pulkova led Galitzin to discern the existence of three new "critical surfaces" at the depths of 106, 232, and 492 km. Prof. Turner remarks that the relative depths of earthquake foci also concentrate about three chief values. The absolute depths are unknown, but, if they are the same as those of Galitzin's surfaces, they result in a surface value of the P waves agreeing with that obtained from the Oppau explosion, and suggest that destructive earthquakes probably originate in the uppermost layer, at a depth of 106 km.

Prof. Omori attacks the question from a different point of view, but also depends on time-observations (*Japanese Journ. of Astr. and Geoph.*, vol. 1, 1922, abstracts p. 16). He finds that the distance (x km.) of a station from the earthquake centre and the duration (y sec.) of the first preliminary tremor at the station are connected by the relation $x = 7{\cdot}42y$. From observations made at three stations (Tokyo, Mito, and Choshi), he finds that the focal depths of ten earthquakes felt at Tokyo in 1919–1921 range between 27·5 and 46·0 km., with an average of 34 km. In a later paper (*Seismol. Notes*, vol. 1, No. 3), he assigns, by the same method, a depth of 48 km. to the focus of the semi-destructive Tokyo earthquake of April 26, 1922. C. D.

University and Educational Intelligence.

BELFAST.—At the meeting of Senate of the Queen's University held on April 20, it was agreed to receive the resignation of the vice-chancellor, the Right Honourable and Rev. Thomas Hamilton. Dr. Hamilton was appointed vice-chancellor by Queen Victoria in 1889 as president of Queen's College. At that time the annual endowment was 8000*l.* and the number of students less than 400. The annual endowment is now 36,000*l.* and the number of students 1250. During his long presidency his services were invaluable. In 1901 a fund of 100,000*l.* for the better equipment of the College was received, which made possible the erection of laboratories for teaching and research. By the Universities Act of 1908 the Queen's College was dissolved and became the Queen's University, and Dr. Hamilton was named in the charter as vice-chancellor and president. The Senate appointed a special committee to make inquiries as to a person suitable for nomination to the office of president and vice-chancellor.

LEEDS.—The Leeds Education Committee and the University have co-operated in setting up a new course of training for students who may expect to occupy posts of directive responsibility in the printing trades. The University has no Printing Department of its own; but in other respects is able to offer the kind of training which is needed by a man who will afterwards take a responsible position in business life. The Leeds Technical School Printing Department, on the other hand, is to provide technical training in the various processes of printing and the full course will extend over four years. The first three years will be spent in reading for the University degree, one of the subjects for which will be printing. A fourth year, leading to a diploma, will be spent wholly on printing at the Technical School. The work for the degree will comprise economics, including commercial and financial organisation and the economics of the printing and allied industries, statistics, accountancy, commercial law, mathematics, physics, mechanical engineering, and printing. The scheme will come into operation next October.

The Dewsbury County Borough Council has voted a grant of 400*l.* a year to the University and the Halifax County Borough Council has made a grant of 750*l.* for the current financial year.

Dr. R. W. Whytlaw-Gray, Fellow of University College, London, has been appointed professor of chemistry as from October 1 in succession to Prof. Arthur Smithells. From 1900 to 1902 Dr. Whytlaw-Gray worked under Sir William Ramsay on a redetermination of the atomic weight of nitrogen. This work was completed in the laboratory of Prof. R. Anschütz in the University of Bonn. On his return from Germany in 1906 Dr. Whytlaw-Gray was appointed on Sir William Ramsay's staff at University College, London, and in 1908 he became assistant professor. While there, he conducted important investigations on the physical constants of gases and was associated with Sir William Ramsay in the well-known work on radium emanation (niton). This work involved exceptional experimental difficulties, less than one-tenth of a cubic millimetre of the gas being available. With this almost infinitesimal quantity Messrs. Ramsay and Whytlaw-Gray succeeded in determining its physical properties, thus proving that the emanation belonged to the helium family of elements. In connexion with this very delicate work, Dr. Whytlaw-Gray constructed a specially designed balance which was sensitive to 1/250 thousandth of a milligram. Since 1914 Dr. Whytlaw-Gray has been science master at Eton College.

LONDON.—A course of eight free public lectures on "Nutrition" will be given at King's College for Women (Household and Social Science Department), 61 Campden Hill Road, W.8, by Prof. V. H. Mottram, on Mondays and Wednesdays, beginning on April 30. The lecture hour is 4.30, and no tickets are required.

OXFORD.—The next award of the Rolleston Memorial Prize will be made in Trinity Term, 1924. The Prize, the value of which is about 100*l.*, is given for original research in animal and vegetable morphology; physiology and pathology; or anthropology. Candidates must be graduates of Oxford or Cambridge of not more than six years' standing. For other conditions the *Oxford University Gazette* for April 11 should be consulted. Candidates wishing to compete must forward their memoirs to the Registrar of the University of Oxford before March 31, 1924.

MR. GEORGE GRANT, Appointments Secretary and Senior Warden of the University Halls of Residence for Men Students, University of Liverpool, has been appointed Registrar of University College, Southampton, as from September 1, 1923.

DR. S. P. SMITH has been appointed professor of electrical engineering at the Royal Technical College, Glasgow, in succession to Prof. Magnus Maclean, who is about to retire after occupying the chair for twenty-four years. Since 1912, Dr. Smith has been lecturer, and later assistant professor, in the Electrical Department of the City Guilds (Engineering) College, Imperial College of Science and Technology, London.

AN important conference is being organised by the University of Leeds for the discussion of certain questions affecting the supply of full-time education for boys and girls beyond the age of eleven years and the choice of subjects in school examinations. The conference will be held in the Great Hall of the University on Saturday afternoon, June 9, and will be attended by representatives of schools and universities, as well as by others engaged in educational work. The main subject of discussion will be the broadening of the basis of the secondary-school curriculum. Though less than three per cent. of pupils in State-aided secondary schools proceed to universities, the courses usually followed lead to examinations of university matriculation standard and scope, and are unsuitable for pupils who will not continue their education at universities. The following motions will therefore be put before the conference for consideration, and a vote will be taken upon them:—(1) That representations be made to the Board of Education, urging the pressing need of further provision (by legislative change, if necessary) for the full-time education of boys and girls up to the age of sixteen, to include not only instruction of the type now offered by the recognised secondary schools, but such variations from it as will meet the needs of pupils who may not intend to proceed to a university. (2) That this conference welcomes the recent action of the Joint Matriculation Board of the Northern Universities in the direction of allowing greater freedom in the choice of subjects in the First Secondary School examination, but is of opinion that greater freedom in the grouping of courses for the Higher Certificate is desirable in the educational interests of the pupils in secondary schools. Correspondence on the subject of this conference may be addressed to Sir Michael Sadler or to Mr. A. E. Wheeler, The University, Leeds, who will be glad to have the names of those intending to be present at the conference.

Societies and Academies.

LONDON.

Geological Society, March 28.—Dr. H. H. Thomas, vice-president, in the chair.—E. **Greenly**: Further researches on the succession and metamorphism in the Mona complex. Fragments from the volcanic series of Bangor show that the metamorphism of the complex is older than that series. The basic schists of the Eastern Aethwy region appear to be derived from the spilitic lavas. A singular effect of anamorphism in its earliest stages is that quartz-epiclasts have been corroded and invaded by the carbonates of a calcareous grit. Titaniferous varieties of the Bodwrog marble in the Penmynydd Zone furnish evidence as to the conditions of development, under dynamic metamorphism, of rutile and of sphene. As regards the ancient floor, more fragments of ancient crystalline schists have been found, one of them being in the Fydlyn Beds, a lower horizon than any that had hitherto yielded any such fragments. The gneissic structures are older than the deposition of the bedded succession. Banding resulted from deformation of a differentiated basic magma at an advanced stage of consolidation. Three generations of pegmatite are distinguished, the earliest of which is subsequent to the consolidation of the banded gneiss. Granitoid banding followed granitoid permeation, and also the appearance of the basic magma from which the hornblendic gneisses were developed. Thus, the micaceous gneisses must be regarded as the oldest known member of the gneissoid complex.

Aristotelian Society, April 9.—Prof. A. N. Whitehead, president, in the chair.—C. D. **Broad**: Various meanings of the term "unconscious." Six senses of the term "unconscious" are distinguished. (1) As used to differentiate one kind of substance from another, it means "inanimate." (2) As applied to the temporary condition of an animate substance, it means "not at the moment consciously aware of anything." This definition is not complete till we have defined (3), "conscious" and "unconscious," as applied to experiences. An experience is "relatively unconscious" if it is owned by some mind which is not at the time in control of a body. It is "absolutely unconscious" if, at the time of its occurrence, it is owned by no mind. These are the only senses in which we can *literally* talk of "unconscious *experiences*." (4) The traces and dispositions which have to be assumed in order to explain memory, instinctive behaviour, etc., are often called "unconscious states." There is no reason to think that these are, or are anything like, experiences. It is best to call them "mnemic continuants." (5) Experiences which were conscious when they happened, but cannot now be remembered by normal means, are often called "unconscious." It would be better to call them "inaccessible." Their traces form part of the unconscious in sense (4). They themselves are not literally unconscious experiences in sense (3). Lastly, (6) the name "unconscious" is often applied to ordinary conscious experiences (especially desires and emotions) which are not properly discriminated by their owner because the acknowledgment of their true nature and objects would be unflattering to him.

Royal Meteorological Society, April 18.—Dr. C. Chree, president, in the chair.—W. H. **Dines** and L. H. G. **Dines**: An examination of British upper air data in the light of the Norwegian theory of the structure of the cyclone. A list of dates on which temperature observations were available in England S.E. was sent to the Meteorological Office, which notified all those on which evidence of the polar front might be expected. Graphs of the lapse rate from 0·5 km. to 5·0 km. were drawn for such dates, but no peculiarities not readily explained by the ordinary casual variation were found. The probability of finding an inversion appears to be almost a linear function of the surface pressure. Kite ascents made at Pyrton Hill indicate that an inversion is nearly always associated with a decrease in the humidity, whereas the Norwegian theory requires an increase. The observational evidence for England does not support the theory that the superposition of equatorial over polar air is the usual form of the structure of a cyclone.—T. **Kobayasi**: On the mechanism of cyclones and anticyclones. Mathematical expressions are obtained which represent a cyclone having definite properties. As the cyclone advances it draws into its inner region a strip of air lying near the ground in its track. Meanwhile the air outside the two edges of the strip flows round the opposite sides of the cyclone, meeting behind it. Thus if the portions of air outside the two edges of the strip were at different temperatures, then by their contact they would produce the instability which is characteristic of the squall line.—E. C. **Shankland**: Notes on the fluctuations of mean sea-level in relation to change of atmospheric pressure. The heights to which tides will rise in the world's principal harbours and estuaries are pre-determined by analysis and presented to navigation in the form of tidal predictions. Meteorological conditions interfere with these predictions. Observations show that the mean sea-level varies inversely with the height of barometer; there is a tendency to increase the factor from 13·25 (the specific gravity of mercury as compared with sea-water), to a figure approaching 20 when using the mean isobar of the locality as barometric datum. Observations extending over a period of autumnal anti-cyclonic weather of considerable geographic extent, point to the acceptance of a 1/20 factor under these meteorological conditions, the barometric pressure being above normal during the entire series.

PARIS.

Academy of Sciences, April 3.—M. Guillaume Bigourdan in the chair.—Emile **Picard**: Two elementary theorems on the singularities of harmonic functions.—M. de **Sparre**: The yield of reaction turbines furnished with aspiration tubes. Modifications of the formulæ given in earlier communications produced by the addition of an aspiration tube, with and without partitions. An example is given in which the initial maximum yield was 0·816, with simple aspiration tube 0·865, and a still higher figure for certain cases of tubes with partitions.—E. **Mathias**, C. A. **Crommelin**, and H. Kamerlingh **Onnes**: The latent heat of vaporisation and the difference of the specific heats in the saturated state for neon. A table is given showing the molecular heats of vaporisation for oxygen, argon, nitrogen, neon, and hydrogen.—S. **Lefschetz**: The integrals of the second species of algebraical varieties.—G. **Valiron**: Remarks on a theorem of M. Carlemann.—Hilaire de **Barenton**: A new interpretation of the Sothaic period. A new theory of the ancient Egyptian calendar.—L. **Vegard**: The spectrum of the aurora borealis and the upper layers of the atmosphere. An account of work done at the Tromsö Geophysical Institute. The greater number of the lines in the spectrum of the aurora borealis can be identified with nitrogen lines, but there are four lines not given for nitrogen, which cannot be attributed to hydrogen, oxygen, or helium. There is no evidence for the existence of hydrogen or helium in the upper

atmosphere. It is possible that the four lines not identified, including the green line (5578·4), may be due to nitrogen.—L. **d'Azambuja**: New measurements of the velocity of rotation of the filaments. Evaluation of the height of these objects above the solar chromosphere. The average velocity does not sensibly vary from one filament to another: it is independent of the shape, intensity, and extent of the filaments observed. There is a clear reduction of velocity toward the pole, the angular velocity being $14{\cdot}45° - 1{\cdot}90° \sin^2 \lambda$, where λ is the heliographic latitude.—Louis **Dunoyer**: Induction spectra and spark spectra. Reclamation of priority as regards work by Léon and Eugène Bloch, and a discussion of the nomenclature of spectra.—Pierre **Lamare**: Geological observations on the Yemen. The region of the Yemen (south-west angle of Arabia) presents remarkable geological and lithological analogies with the Somali and Abyssinian regions. The properties of the six main types of basalts are summarised.—C. E. **Brazier**: Magnetic measurements in Normandy. The magnetic elements (on January 1, 1922) are given for 43 stations in the Departments of Eure and Seine-Inferieure.—Mlle. Y. **Dammann**: The Kansou earthquake: determination of the epicentre. This earthquake took place on December 16, 1920, in the north China province of Kansou, and for the determination of the epicentre the seismological records from 24 observatories were utilised.—Mme. J. Samuel **Lattès**: Some numerical values characterising the radium rays responsible for the phenomenon of necrosis.

Official Publications Received.

Papers and Proceedings of the Royal Society of Tasmania for the Year 1922. Pp. v+104+8 plates. (Hobart: Tasmanian Museum.) 10*s*.

Reports of the Council and Auditors of the Zoological Society of London for the Year 1922, prepared for the Annual General Meeting to be held on Monday, April 30, 1923. Pp. 55. (London.)

Review of Agricultural Operations in India, 1921-22. Pp. vi+160. (Calcutta: Government Printing Office.) 1.4 rupees.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 6, No. 2: On some Tertiary Brachiopods from Japan. By Ichirō Hayasaka. Pp. 25+2 plates. (Tokyo and Sendai: Maruzen Co. Ltd.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1922. Pp. ii+14. (Cape Town.)

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karroo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1922. Pp. 23. (Kirstenbosch.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. New Series, No. 15, April. Edited by W. F. Spear. Pp. 196. (London.)

Diary of Societies.

SATURDAY, APRIL 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (1).

MONDAY, APRIL 30.

INSTITUTE OF ACTUARIES, at 5.—A. D. Besant: Notes on some Actuarial Aspects of the Local Government and other Officers' Superannuation Act, 1922, and on a Method suitable for the Initial Valuation of a Small Fund of the "Officer" Type.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Spina Bifida, etc.

ROYAL SOCIETY OF ARTS, at 8.—S. S. Cook: Recent Improvements of the Steam Turbine (1). (Howard Lecture.)

TUESDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (4). Are our Bodies Changing?

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

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. H. Dale: The Activity of the Capillary Blood-vessels, and its Relation to Certain Forms of Toxæmia (Oliver-Sharpey Lectures) (1).

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. G. Tutton: Three-colour Carbro.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—V. G. Childe: The Neolithic Painted Pottery of South-Eastern Europe.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—C. Thurstan Holland: X-rays and Diagnosis (Sixth Silvanus Thompson Memorial Lecture).

WEDNESDAY, MAY 2.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. Joly: The Bearing of Some Recent Advances in Physical Science upon Geology.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Prof. C. L. Fortescue: The Design of Inductances for High-Frequency Circuits.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—W. Dickson: The Quantitative Determination of Hemp and Wood in Papers containing these two Fibres.—H. Jephcott: The Estimation of Fat, Lactose, and Moisture in Dried Milks.—A. L. Bacharach: The Estimation of Lactose by the Polarimetric and Gravimetric Methods.—M. S. Salamon: The Melting Point and Iodine Value of Refined Natural D. Camphor.—A. G. Francis: The Presence of Barium and Strontium in Natural Brines.

ROYAL SOCIETY OF ARTS, at 8.—M. Drake: The Fourteenth-century Revolution in Glass Painting.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (Thirteenth Annual May Lecture).

THURSDAY, MAY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. T. MacGregor Morris: Modern Electric Lamps (2). Glowing Solids in Gases.

ROYAL SOCIETY, at 4.30.—F. A. E. Crew: Studies in Intersexuality. I. A Peculiar Type of Developmental Intersexuality in the Male of the Domesticated Mammals.—E. J. Morgan and J. H. Quastel: The Reduction of Methylene Blue by Iron Compounds.—C. F. Cooper: The Skull and Dentition of *Paraceratherium bugtiense*. A genus of aberrant Rhinoceroses from the Lower Miocene Deposits of Dera Bugti.—Dr. W. L. Balls: The Determiners of Cellulose Structure as seen in the Cell Walls of Cotton Hairs.—I. de B. Daly: The Influence of Mechanical Conditions of the Circulation on the Electrocardiogram.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. W. T. Gordon: The genus *Pityx*.—R. Gurney: The Crustacean Plankton of the English Lake District.—S. L. Ghose: A Systematic and Ecological Account of Blue-green Algæ from Lahore.—J. Groves: Notes on Indian Charophytes.—J. G. H. Frew: The Morphology of the Head and Mouth-parts of *Chlorops tæniopus* Meig. (Diptera).—A. M. Alston: The Genital System of the Beetle *Lyctus brunneus* Steph.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. H. Dale: The Activity of the Capillary Blood-vessels, and its Relation to Certain Forms of Toxæmia (Oliver-Sharpey Lectures) (2).

CHEMICAL SOCIETY, at 8.—Prof. H. B. Baker: Change of Properties of Substances on Drying. Part II.—H. Bassett and P. Halton: The Sodium Salts of Phenolphthalein.—H. Bassett and R. G. Durrant: The Action of Thiosulphates on Cupric Salts.—R. G. W. Norrish and Dr. E. K. Rideal: The Conditions of Reaction of Hydrogen with Sulphur. Part II. The Catalytic Effect of Oxygen. Part III. On the Mechanism of the Reaction of Hydrogen with Sulphur and its Catalysis by Oxygen.—Prof. T. M. Lowry: Studies on Electrovalency. Part II. Co-ordinated Hydrogen.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rational Study of Optical Properties: Refraction a Constitutive Property.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—L. P. Pugh: Investigation into Ovarian Disease in Cows.—Dr. A. Donald: The Clinical Aspects of Adenomyomata of the Female Pelvic Organs.

FRIDAY, MAY 4.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—The Volatilisation of Meteors, in relation to the Density and Temperature of the Air at 60 km. Chairman, Prof. A. S. Eddington. Opener, Prof. F. A. Lindemann; other speakers, Major G. M. Dobson, Sir Napier Shaw, and F. J. Whipple.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Richard T. Glazebrook: The Interdependence of Abstract Science and Engineering (Twenty-ninth James Forrest Lecture).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. A. Stigant: A.C. Neutral Point Earthing.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. F. Soddy: The Origins of the Conception of Isotopes.

SATURDAY, MAY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (2).

PUBLIC LECTURES.

MONDAY, APRIL 30.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 4.30.—Prof. V. H. Mottram: Nutrition. (Succeeding Lectures on May 2, 7, 9, 14, 16, 23, and 28.)

TUESDAY, MAY 1.

KING'S COLLEGE, at 5.30.—Prof. A. P. Newton: Africa and Historical Research.

THURSDAY, MAY 3.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Prof. W. Bulloch: Spallanzani's Researches on Respiration.

FRIDAY, MAY 4.

UNIVERSITY COLLEGE, at 5.—W. Macnab: Some Scientific Principles of Chemical Industry. (Succeeding Lectures on May 11 and 18.)