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APR 20 1916

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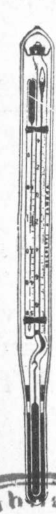

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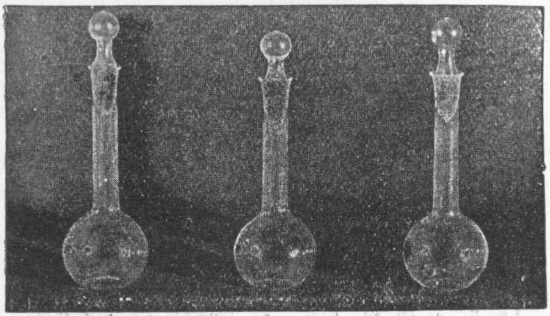

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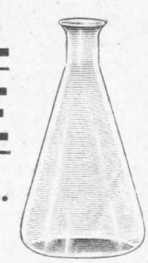

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THURSDAY, FEBRUARY 17, 1916.

SCIENCE IN THE PUBLIC SCHOOLS AND THE CIVIL SERVICE.

FROM the welter of the billows which have recently beaten about the place of science in education, in the columns of the periodical Press, two main points stand out, namely, those of the dominance of classical and literary teaching in our great Public Schools, and its influence upon the older universities and the public Services. Our political leaders and administrators of State departments are in the main trained in these schools, where vested interests preserve the prime places in the curriculum for ancient learning, and scientific subjects are discouraged for students who hope to obtain university scholarships or appointments in the highest ranks of the Civil Service.

The position of affairs has been stated clearly in correspondence published in the *Observer* during the past few weeks, particularly with reference to the undue proportion of open scholarships allotted to classics at the older universities. There is no question as to the facts, but Dr. A. E. Shipley and Mr. H. A. Roberts attempt to justify, or rather to explain, them by standards of attainment. They point out that the award of scholarships depends upon the ability of the candidates presenting themselves, and assert that real ability is found much more rarely among those who offer scientific subjects than among the candidates who have selected classics. "No candidate," they say, "in natural science who reaches the necessary standard of ability is likely to be rejected. But the supply of candidates of sufficient ability is not so great as it should be."

This is especially true of candidates from the great Public Schools, and it is with this deplorable condition of things that we are at the moment most concerned. In a recent year, according to Dr. Shipley and Mr. Roberts, in one of the greatest of such schools, excellently equipped for scientific studies, less than 2 per cent. of the boys in the higher forms were giving special attention to science, and only one or two of these were of sufficient ability even to appear as competitors in any scholarship examination at the universities, so that "the contribution of this great school to the scientific ability of the country was less than one-fifth of 1 per cent. of the total numbers of the school."

We should have supposed that such facts as these would be sufficient to condemn the present system, and to induce advocates of reform to make the most strenuous efforts to alter it. The "Converted Classic," to whose remarks the letter by Dr. Shipley and Mr. Roberts was intended as a reply, asks pertinently why the universities thus submit to the dictation of the Public Schools as to the relative value of science and classics instead of themselves prescribing subjects, and by limiting the awards to classics to induce the headmasters to give adequate attention to science.

"The study of classics," he adds, "is a luxury, and should be treated as such; the study of science is a real and present necessity. Classical training tends to produce the official; scientific training tends to produce the man of initiative and action—the creator. Which of the two types is the more necessary at the present time? Let, then, higher education take the initiative; let the 'Varsities force the schools, for in their hands, to a great extent, lies the remedy."

It is not at all certain that the headmasters of the Public Schools would adopt a new attitude towards science even if the universities limited the number of classical scholarships in the manner suggested; for most of the pupils sent up are not scholarship candidates. The result of the action would, however, encourage the development of scientific work in the State secondary schools, and the end would be that these schools would secure the science scholarships, while as regards the current of modern needs the Public Schools would be in a backwater. They may be content to occupy that position, but there is no reason why a premium should be placed upon their unprogressive methods. What we have to get rid of is the idea, naïvely expressed by a correspondent in the *Westminster Gazette* a few days ago, that the classical studies of the ancient schools and universities should be reserved for men who are to occupy the highest branches of the public Services. The assumption that classical languages and literature are essential to the education of people who are to control our affairs, and that a knowledge of science is not needed in this capacity, is responsible for the chief defects which have to be remedied if we are to compete successfully in peace or war with other leading nations. A truer view is that no one should be entrusted with the administration of affairs of State who has not received a scientific education, and that classical learning should be considered as an intellectual hobby.

As things are at present, it pays far better to study classics than science, if a post of importance in the Civil Service is the proximate or ultimate end. The examinations for Clerkships (Class I.)

bear much the same relationship to the older universities that the universities bear to the Public Schools. Candidates for appointments in the Home and Indian Civil Services, and for Eastern Cadetships, are at liberty to select any of thirty-eight subjects, provided that the total number of marks carried by the subjects does not exceed six thousand. At least ten or twelve subjects must be taken, and a high standard reached in them, in order that a candidate may have a reasonable chance of success. The majority of the successful candidates select Greek and Latin, English history, language and literature, mental and moral science, and political economy. Occasionally, a brilliant mathematician will secure a good total of marks, but candidates who specialise in science rarely obtain a high place.

The considerations which determine largely the nature of the subjects selected are the relative number of marks obtainable and the attention given to different branches of study at the Public Schools and the older universities. Greek and Latin languages and literature have each eleven hundred marks, and five hundred each in addition for Greek and Roman history. The only subjects which compare with these as regards allocation of marks are included in the groups Lower and Higher Mathematics, each of which has a maximum of twelve hundred. Chemistry, physics, geology, botany, zoology, animal physiology, and geography carry six hundred marks each, but not more than four science subjects can be offered—the candidate who will present himself for examination in more should certainly not be encouraged—or three if both Lower and Higher Mathematics are taken.

A fairly high standard of attainment is thus required in four separate branches of science in order to hope for the same number of marks as can be obtained for a knowledge of Greek and Latin language and literature. This fact, and the predominance of classical studies and interests in the educational institutions most favoured by the wealthier classes, is responsible for the selection of subjects by candidates who present themselves for examination. At the examination held just before the war began there were 206 candidates for 78 appointments. Of those who were successful only four offered science subjects without mathematics or classics, and seventeen owed their position to marks from mathematics with science. Forty-five specialised in Greek and Latin, and the remainder presented themselves in other literary subjects, with or without mathematics.

This analysis is typical of results of examination for Clerkships (Class I.), and it shows that the great majority of the men appointed to the highest positions in the Civil Service, and by whom national affairs are to be administered, are specialists in classics without an elementary knowledge of science, and with no conception, therefore, of the meaning of scientific method. It follows almost naturally that nearly all the successful candidates are from the universities of Oxford and Cambridge, and especially from Oxford. It is possible that the Civil Service Commissioners believe that their system of marking gives an open field to all students—whether classical, scientific, or linguistic—but the result is the same as that from the selection of scholarship candidates, namely, the appointment of few men of scientific attainments; and the cause of it all is the neglect of science, and the predominance of classics, in the curriculum of the Public Schools.

In 1914 the Royal Commission on the Civil Service recommended the Government to appoint a committee with the object of ascertaining whether there is any substantial foundation for the view which certainly prevails that the scheme for examination for Class I. unduly favours the curricula of the older universities and handicaps those of the newer. It was suggested that, should it be found any change is desirable, the committee, while maintaining the high standard necessary for the examination, should revise and rearrange the syllabus, weighing the educational value of classical learning against those of modern and scientific studies. The committee has not, so far as we know, yet been appointed, and we are not very sanguine as to the effect of any changes which it might recommend, while the work of our Public Schools remains almost entirely in the hands of classical headmasters. They and the parents trained on the Chinese method seem to be incapable of understanding why the needs of the present day differ from those of past centuries.

Latin and Greek were first introduced into our schools as a means of acquiring new knowledge, and not because of their supposed formative influence upon character. When Augustine established the first grammar school in England, at the end of the sixth century, Latin was taught in order that the native priests, and converts of the upper classes, might understand the rudiments of the new religion. From that time to the Renaissance and onward, the learning of Latin was the whole aim and end of education in schools; because the language was the living tongue of scholars. For, as the late Mr. A. F. Leach points out in his "Schools of Medieval England," people wanted to know Latin, not to write Latin verses in imitation of Vergil, but to speak it or to read the latest work on theology or tactics or geography. The introduction of Greek into the curriculum of schools came with the Renaissance, but was not, as is often suggested, responsible for the birth of the new learning. Greek was introduced into Winchester and Eton, New College and Magdalen, in the fifteenth century, because these schools and colleges were the advanced institutions of the day, and their scholars the leading humanists of their age, eager for new light. Humanism then meant the substitution of new teaching for old, and its followers aimed at moulding "the nature of man as a citizen, an active member of the State," rather than at continuing the studies of doctrines relating to the next world upon which the attention of educated mankind had been concentrated for a thousand years.

We want to see a like recognition of the need of scientific knowledge on the part of the humanists of to-day, in the place of that attitude of obscurantism which they present to it. We want to make science the keynote of our Public School and University system, as Humboldt and others did in Prussia at the beginning of the nineteenth century, when Germany was under the heel of Napoleon; for to it are due the position and power gained by that country since then. The lesson which the French learnt from their disaster in 1870 was that attention must be given to education at every stage, and more especially to higher education, in order to secure their position most effectively. Are we to await like defeat before taking the necessary steps to ensure that our legislators, governing officials, and others who exert the highest influence in the State receive the scientific education which modern life demands?

CATALYSIS.

Text-books of Chemical Research and Engineering. Catalysis and its Industrial Applications. By E. Jobling. Reprinted from *The Chemical World.* Pp. viii+120. (London: J. and A. Churchill, 1916.) Price 2s. 6d. net.

THIS little book consists of a series of articles originally contributed to *The Chemical World,* and deals with a class of phenomena which have attracted special attention of late years owing to their growing importance in many operations of chemical technology. The fact that certain chemical processes can be initiated or greatly accelerated by the presence of some foreign material which *apparently* remains unchanged was recognised in the early part of the last century and denoted by the term *catalysis,* first applied by Berzelius in 1835. One of the earliest facts which is brought to the knowledge of the chemical tyro is the influence of manganese dioxide in promoting the disengagement of oxygen from potassium chlorate, and if he ponders at all upon the circumstance one of his earliest impressions must be of the inadequacy or unsatisfactory nature of the explanation of the cause of the phenomenon. But as his knowledge increases he learns to recognise that the influence of extraneous substances in promoting chemical change is in reality a very common phenomenon. At the same time, comparatively little is known of the mechanism of these catalytic actions. In a few cases it has been definitely ascertained that the catalytic agent does experience a series of changes. During the course of a reaction it is being continually decomposed and recomposed, and by suitable means the presence of the intermediate product can be detected. Hence it is reasonable to suppose that all catalytic phenomena depend upon the alternate decomposition and recomposition of the catalytic agent. Another curious fact brought to light by the industrial application of catalysis is that the activity of a catalytic agent may be wholly inhibited by the presence of another foreign body or, in the language of the technologist, of a so-called *poison.*

In Mr. Jobling's book much that is known of a rapidly developing subject has been brought together and described in a clear and interesting manner. In an introductory chapter he deals with the purely scientific aspects of catalysis and the characteristics of catalytic reactions, autocatalysis, pseudo-catalysis, etc. The rest of the book is concerned with the industrial applications of catalytic agents, as, for example, in the manufacture of sulphuric acid by so-called contact processes; of chlorine and salt-cake by Deacon and Hasenclever's process and the methods of Hargreaves and Robinson; of sulphur recovery by the Claus-Chance and Gossage processes; of the fixation of atmospheric nitrogen by the Haber and Ostwald's processes, etc.; of surface actions as illustrated by the work of Bone and his co-workers on surface combustion; incandescent gas-mantles, etc.; of hydrogenation, the work of Sabatier and Senderens and its application to the "hardening" of oils—a phenomenon of the greatest practical utility. Lastly, we have two short chapters on dehydrogenation and oxidation; and on dehydration, hydrolysis, etc., interesting as serving to throw light upon a variety of complex reactions depending apparently upon catalytic agencies, and as suggesting their applications in technical processes.

The book deserves the serious attention of every student of chemistry. It will open his eyes to the boundless possibilities of a field of inquiry of which even the very fringes have only been very imperfectly explored as yet, but which, there is no doubt, is destined to yield fruit of the greatest richness and value.

THE STUDY OF VARIABLE STARS.

An Introduction to the Study of Variable Stars. By Dr. C. E. Furness. Pp. xx+327. (Boston and New York: Houghton Mifflin Co., 1915.) Price 1.75 dollars net.

IT has been said that it is more important to measure the light than the place of a star. Add the time factor and there is the observational province of the student of variable stars, namely, the measurement of the relationship between time and lustre of particular stars. The present book is largely given up to explaining methods by which this can be accomplished The author is one who has had almost unique opportunities fitting her to undertake the task, which might have been more successfully carried out had the aim been more ambitious. As director of Vassar College Observatory, Dr. Caroline Furness has not only actively engaged in variable star observation, but has also conducted the regular courses of study in this special subject in the astronomical department of the College. These occupations have ensured the necessary documentation and provided valuable experience in the practice of stellar observation, in the art of exposition, and especially in the needs of novices in this important branch of sidereal physics. The volume, it may here be mentioned, finds a place in the "Semi-centennial Series" of works by distinguished alumni issued in commemoration of the fiftieth anniversary of the foundation of Vassar, and at present it stands alone in the English language.

The intention of the work is primarily to *make* observers, and the practical side of the subject is kept prominently to the fore throughout. The historical aspect, however, receives considerable attention, and much interesting material has been collected. With the first aim in view the author attempts to supply the reader with concise information on a range of preliminary subjects such as "Durchmusterung charts," "photometry in all its branches," "spectroscopy," "star colours," etc. These efforts lead to a tedious description of star maps and charts, a summary of the rudiments of spectrum analysis, a lengthy non-technical account of Nichol's prism, taken, it would seem, from a well-known English text-book of physics, and, among other things, to the inclusion of an abstract of a paper on the physiological optics of the colours of double stars. This paper is sufficiently interesting, but it would have been better to describe the work of Hertzsprung, for example, or that of Tikoff; and instead of introducing the gentle gibe at the fanciful colour scheme employed in such an ancient work as Webb's "Celestial Objects," Espin's or Frank's colour scales might have received mention.

Although the title admittedly affords the author considerable liberty in choice of material, yet, since in these days the historical scale of star magnitudes has been everywhere abandoned, perhaps the sole important exception being the catalogue of Boss, there might well have been given some account of the absolute scale of magnitude adopted by the astrographic conference in 1909, especially as this crowned the thirty years' work of an American astronomer, Prof. E. C. Pickering.

So much attention is now being claimed by photo-electric photometry that many who cannot turn to the original memoirs will read the chapter on this topic with interest. As no account is given of work on, or with, selenium prior to that of Stebbins, it may be permissible to recall some facts not so widely known as they deserve to be. Announced by Mr. Willoughby Smith early in 1873, a little later Lieut. Sale, R.E., investigated quantitatively the effect of varied illumination on the conductivity of that element, the property employed in the commercial selenium bridges used in 1907 by Stebbins with such great success. Three years after Sale's experiments, Prof. Adams and Mr. R. E. Day detected the potential difference set up under similar conditions. The late Prof. G. M. Minchin applied this fact nineteen years later, in 1895, in what would appear to have been the first successful photo-electric measures of stellar radiation ever made.

It is rather to be regretted that space was not found for some discussion of the classification of variable stars instead of merely stating that the Harvard scheme is best known and most widely used. It may be, but it bears much the same relationship to present-day knowledge of stellar variability that Secchi's classification does to the Harvard classification of stellar spectra.

The later history of Novæ is even more interesting than would appear from p. 255. It has now been established that in their latest phases several, at any rate, have assumed the Wolf-Rayet features after passing through the nebular stage. It may here be mentioned that the note on p. 36 does not contain Prof. Fowler's latest conclusions regarding the Pickering and the

Rydberg series lines. In 1914 he ascribed these series to proto-helium.

An English writer would have referred to the Franklin-Adams star charts, and instead of the atlases of Heis, Schurig, or Upton, British readers will no doubt prefer, according to ambition and purses, Cottam's charts, or the atlases of Peck, Proctor, or Norton.

It is a decided merit of the book that it contains a large number of references to original publications. Moreover, it is well printed and free from typographical faults (a gross example was noticed on p. 165). It may be pointed out that the "Rutherford" several times mentioned should be "Rutherfurd," and that a revised edition of the late Miss Clerke's "System of the Stars" appeared about ten years ago. These two books, it may be stated, are in a degree complementary.

H. E. GOODSON.

OUR BOOKSHELF.

Alcohol and the Human Body. By Sir Victor Horsley and Dr. M. D. Sturge. Fifth edition. Pp. xxviii + 339. (London: Macmillan and Co., Ltd., 1915.) Price 1s. net.

IN this book, which has now reached a fifth edition, a striking array of statements and facts is marshalled on the deleterious effects of alcohol on the human body. The first chapter deals with the action of alcohol as a drug, the second with the chemistry of alcohol and of alcoholic beverages. The remainder of the book deals with the action and effects of alcohol—on the cell, on the various tissues and organs, on the metabolism of the body, and on the emotions. Concluding chapters discuss the relation of alcohol to disease and tropical conditions, and its use in the Services, and finally Dr. Arthur Newsholme sums up the influence of the drinking of alcoholic beverages on the national health.

The authors are well known for their pronounced views on the alcohol question, and the book must therefore be regarded as being somewhat of a partisan nature, but a good case is made out for the deleterious effects of alcohol even in small quantities, and as a general summary of the whole alcohol question there is probably no better, with the limitation expressed. The text is plentifully illustrated with a number of plates and drawings of the effects of alcohol on the tissues, etc., and with diagrams of statistical and other data.

Proceedings of the Yorkshire Geological Society. Vol. xviii. *Bibliography of Yorkshire Geology* (C. Fox-Strangways Memorial Volume). By T. Sheppard. Pp. xxxvi + 629. (London, Hull, and York: A. Brown and Sons, Ltd., 1915.) Price 15s. net.

YORKSHIRE long ago made its appeal to geologists on account of its magnificent coast-sections, carved out of strata abounding in marine remains. In memory of the work of the late Mr. C. Fox-Strangways, who was so long connected with the Geological Survey, the Yorkshire Geological Society has issued a bibliography which will be of value wherever Carboniferous, Jurassic, and Glacial deposits arouse interest. The work has been based on an incomplete manuscript prepared by Mr. Fox-Strangways, and has been undertaken in a most thorough spirit by Mr. T. Sheppard, of the Hull Museums, who is well known by his "Geological Rambles in East Yorkshire."

The material is arranged chronologically, beginning with Leland's "Itinerary" of 1534. We are glad to see Holinshed's "Chronicle" (1577) quoted as adding something to geology, though here, probably, a page-reference should have been given. The mineral waters attracted scientific attention before the fossil molluscs; but we find M. Lister in 1671 acknowledging in Yorkshire the influence of "M." Steno "concerning Petrify'd shells." An index of 126 pages renders reference easy, and even delightful, to the bibliography. The search for some particular piece of information at once reveals how much more has been published than any reader could have suspected from his own general knowledge.

G. A. J. C.

Chemical Constitution and Physiological Action. By Prof. L. Spiegel. Translated, with additions, from the German by Dr. C. Luedeking and A. C. Boylston. Pp. iv + 155. (London: Constable and Co., Ltd., 1915.) Price 5s. net.

THIS modern branch of treatment is based upon organic chemistry, and in the synthetic preparation of remedies a knowledge of the relationship between chemical constitution and physiological action is obviously necessary. This knowledge, however, is not so advanced that it is possible to foretell what change in a drug's action will be produced by the introduction into it, or the removal from it, of certain organic radicals (alkyls, carboxyl, etc.). Certain chemists take a different view, and hold that data have sufficiently accumulated to warrant such predictions, and the little book under review is written from that point of view.

Pharmacologists and therapeutists, however, who alone have the right to pronounce an opinion because they have practical experience of the action of drugs, are opposed to this enthusiastic opinion. They know that the so-called laws of the chemists have so many exceptions (in fact, as a rule, the exceptions are more numerous than the cases which fit into the chemists' views) that they maintain that the only proof of a drug is the administration thereof. Accurate, careful, and critical discussion of these questions will be found in any standard English text-book of pharmacology, and it is not easy to understand why anyone should have considered it worth while to present to English readers a translation of Prof. Spiegel's German ideas.

W. D. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Place of Science in Education.

THE memorandum regarding the neglect of science to which you refer in your leading article last week fails in my judgment by its moderation. The proposal that at least as many marks in the Civil Service examinations shall be allotted to science as to classics, may be a step in the right direction, but it is a halting one, for it affects only a limited class of the community and does not insist on the *paramount importance* of science in general education. What should be stated is not the least, but the whole of what is necessary. What ought to be made clear is that science must form not a mere adjunct but the actual foundation of the education given in secondary schools. In a word, what is wanted is a *revolution* in our educational system.

Unless the public appreciates the necessity for the change no such revolution is possible; when it does, the mechanism of converting the proposition into action will be simple. If the democracy once understands that we have no chance of keeping our place in the sun unless we are prepared to recognise that whether in peace or war science must be the dominant factor in education all difficulties will disappear. But if this idea fails to take root our place will be lost; and such a place once lost can never be regained. The revelations which have come to light in the course of this bloody war will, we hope, do at least this good, that the people may be induced to appreciate the necessity of basing education upon natural science instead of upon the classics.

The appointment of a Minister of Science which is advocated in the memorandum would under existing conditions be of little use. Whatever qualifications he might be selected for, we may safely prophesy that entire ignorance of the subject he is to administer would be one. It might, however, be argued that this would be a useful asset, for he would at least be gloriously impartial in the various branches of science which would come under his administration.

E. A. SCHÄFER.

University of Edinburgh, February 14.

Relations between the K and L Series of the High-Frequency Spectra.

KOSSEL has shown that for the K and L lines in the high-frequency spectra the following relation holds good:—

$$\nu_{L\alpha} = \nu_{K\beta} - \nu_{K\alpha} \text{ where } \nu \text{ is the frequency.}$$

This relation is deduced on the assumption of the Bohr-Rutherford's atomic model. As the result of new measurements, J. Malmer in his inaugural dissertation, Lund, 1915, states that the K series consists of four lines, called α_1, α_2, β_1, β_2, and that Kossel's relation must take the form—

$$\nu_{L\alpha} = \nu_{K\beta_1} - \nu_{K\alpha_2}.$$

An investigation of the spectra of the L series, which has been carried out by E. Friman and the writer, has shown that there is in reality an additional line near the $L\alpha$, with a slightly greater wave-length. Further, the L series contains two lines, called by Moseley the β and γ lines, which I will denote by β_1 and β_2, as they seem to be a doublet. The ϕ lines observed by Moseley are probably due to some impurities, as they fit fairly well in a series if they are ascribed to other elements. For antimony, we have, according to Malmer, the following relative results:—

		λ		ν
$K\alpha_2$	...	0·472	...	2·119
$K\alpha_1$	...	0·468	...	2·137
$K\beta_1$	...	0·416	...	2·407
$K\beta_2$	...	0·408	...	2·451

From this we get:—

	ν	λ calculated	λ for L series measured
$K\beta_1 - K\alpha_2$	0·285	3·51	3·46 = α_1
$K\beta_1 - K\alpha_1$	0·267	3·74	[3·7] . . α_2
$K\beta_2 - K\alpha_2$	0·332	3·01	[3·06] . β_2
$K\beta_2 - K\alpha_1$	0·314	3·18	3·25 β_1

The values in the last column are those given by Moseley for $L\alpha_1$ and $L\beta_1$, and the values for $L\alpha_2$ and $L\beta_2$ are extrapolated.

MANNE SIEGBAHN.

Physical Laboratories, Lund, Sweden, January 1.

Educational Work in Museums.

IN view of the decision of the Government to close the national museums and art galleries and its probable influence on those responsible for provincial institutions of the same kind, it would perhaps be useful to direct attention to its effect on a branch of museum work which has been started in Manchester as a direct result of the effects of the war.

Owing to the taking over of their buildings for military hospitals, several schools in the Manchester district found themselves temporarily without homes. In order to meet this emergency, the education authorities have instituted what might be termed a half-time system in certain of the remaining schools in order that the scholars from the dispossessed schools should have at least some instruction. The problem then arose of what to do with the scholars for the other half of their time. The Museum Committee was consulted, and asked what help it could render in the emergency, and the keeper of the museum, in consultation with the education authorities, drew up a scheme under which the scholars are now receiving instruction in natural history and Egyptology in the museum buildings.

The education authorities appointed two teachers, already on their staff, to take charge of the work at the museum, one to teach biology and the other geology. The committee placed two rooms at the disposal of the teachers and provided them with duplicate specimens from the reserve collections which could be used and handled freely by both teachers and scholars.

Courses of lessons in geology and natural history were drawn up by the teachers in consultation with the staff of the museum, framed according to the time available and the number of scholars to be dealt with.

Eight classes—of one hour's duration—are held daily, four by each teacher: two in the morning and two in the afternoon. Each lesson consists of from thirty to forty minutes' instruction in the classroom, followed by a tour of the cases in the museum dealing with the particular subject taught, and each course consists of about nine lessons.

In addition to the instruction in natural history the assistant in charge of the Egyptian department gives short courses of lessons in Egyptology to school classes, and four such classes are held weekly.

By these arrangements effective instruction in the museum is provided for 900 to 1000 children per week.

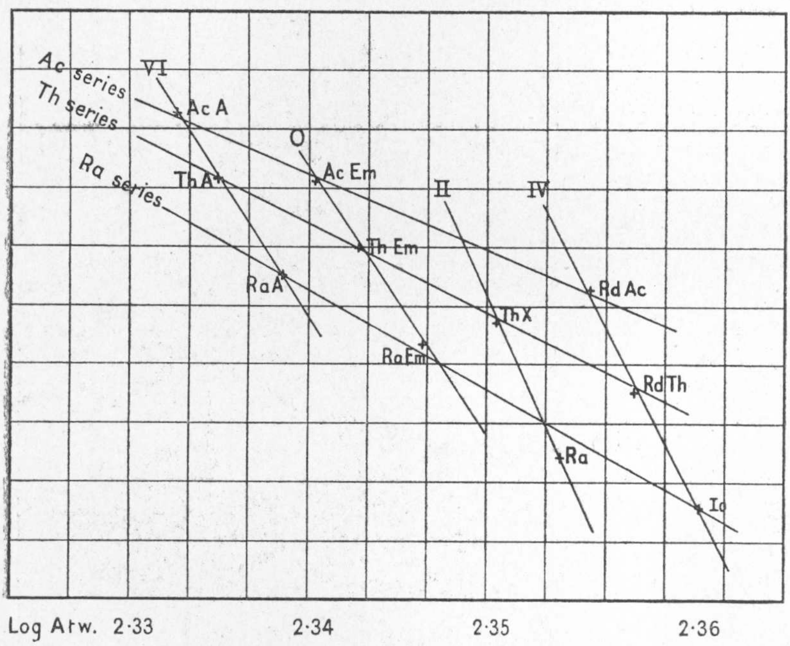
This work was undertaken in response to the appeal of the Education Committee, and in one sense at least it may be regarded as war emergency work. Its real value and usefulness have already been appreciated by the education authorities and by the teachers. But if the museum should be closed down, how can the work go on? What is to be done with the children? They have already been deprived of their schools by the military authorities. It is very desirable that they should not now be denied the valuable alternative instruction provided for them. The same problem will probably arise in many of the provincial towns in the country where similar work is being done.

W. M. TATTERSALL.

The Manchester Museum.

A Relation between Atomic Weights and Radio-active Constants.

THE interesting relation given by Mr. F. Gilbert Carruthers in NATURE of January 20, p. 565, holds, for corresponding isotopes, nearly exactly, if, as suggested by Fajans, the atomic weight of actinium should be 227 instead of 226. From IV. to VI.B the only exception is AcX (and perhaps Ra). But the lines are not parallel, and not equally spaced.



A. VAN DEN BROEK.

Gorsel, Holland, January 25.

Asteroids Feeding upon Living Sea-Anemones.

As bearing upon the observations recorded by Mr. H. N. Milligan in NATURE of February 3, I should like to say that two of ten specimens of *Eupargurus prideauxii*, which have been kept in the aquarium of this institution since last autumn, died on January 23. The molluscan shell occupied by one of these specimens was that of *Trochus magus*, that occupied by the other was of *Scaphander lignarius*. Both shells were, as usual, enveloped by a specimen of the anemone *Adamsia palliata*. When I first noticed the dead hermit-crabs both lay on the gravel at the bottom of the tank with their ventral surfaces uppermost, and in both cases the abdomen was partially withdrawn from the molluscan shell. Both had been attacked and partially enveloped, one by two half-grown specimens of the asteroid *Porania pulvillus*, and the other by one rather larger specimen.

As I have for some time been interested in the feeding habits of Porania and Solaster, I wished to see what would happen and did not disturb the specimens until the following morning. I then found that no appreciable impression had been made by the starfishes upon the soft abdomens of the hermit-crabs; but I was much interested to find that in both cases the enveloping anemone had discharged a considerable number of acontia, with which the actinal surfaces of the starfishes, and probably their partially everted stomachs, had been in contact.

My observations of the feeding habits of Porania have extended over two years, and I have invariably found it an exceedingly slow feeder. As shown by Gemmill (Proc. Zool. Soc., March, 1915, p. 13), this species is capable of subsisting for long periods upon microscopic food particles swept into the digestive tract by ciliary currents. My own observations tend to confirm those of Gemmill; and in view of such a capacity it appears to me to be remarkable that a voluntary attack should have been made upon so large a morsel as the abdomen of a Eupagurus, especially when protected, as is commonly assumed, by an actinian. The anemones did not show any outward sign of injury beyond partial relaxation of their hold upon the molluscan shells.

H. C. CHADWICK.

The Biological Station, Port Erin.

Colourless Crystals of Hæmoglobin.

CRYSTALS of hæmatoidin in old blood extravasations in tissues are not—or at any rate have not been in the cases I have examined—soluble in chloroform or other solvents of bilirubin either with or without acidification. The colour dissolves out readily enough, but a transparent shape remains in the form of the original crystal. I have assumed that this remnant is a proteid basis similar to those which are well known in the crystals of urinary deposits and in calculi, and it is possible that Prof. Fraser Harris's curious experiences with hæmoglobin crystals are explicable along these lines. It is at least likely that hæmoglobin crystals prepared in the ordinary way contain also some serum proteid.

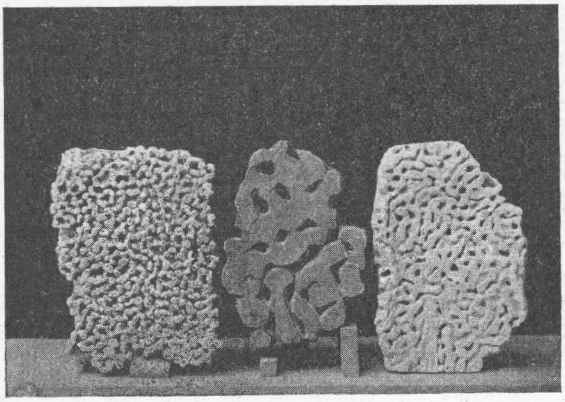
A. E. BOYCOTT.

17 Loom Lane, Radlett, February 4.

Tubular Rock Structures.

THE council of the Geophysics Society desires to obtain records of mineral growths taking the form of hollow cylinders—those not due to organisms, and consisting of either lime, silica, iron, or other elements. Any such information from your readers would be valued.

The Magnesian Limestone of Sunderland has perhaps the largest number of these calcareous growths, of which this illustration shows three specimens. The first and third show clearly the change from rods to



Tubular structures in magnesium limestone. $\times \frac{1}{3}$.

tubes, the last being the most advanced and typical as to size. That in the centre is extra large, but the process is incomplete.

Other illustrations of the structures in the Fulwell Hill beds can be seen in NATURE of January 29 and December 31, 1914. GEORGE ABBOTT.

2 Rusthall Park, Tunbridge Wells, February 3.

WILD AMAZONIA.

THE author, whilst fretting on the Active List owing to ill-health contracted in the interior of East Africa, happened to read Wallace's classical "Travels on the Amazon," with the result that he left England in the month of April, 1908, reaching Manaos by the end of May. His serious work began in the middle of August at Encanto, the place of "enchantment," now by irony of fate of Putumayo fame. Thence he disappeared for some months in the wilderness, roaming over some 40,000 square miles of that no man's land claimed by Brazil, Ecuador, and Peru. His company was composed as follows:—Above all, John Brown, a Barbados negro, as personal servant, who proved himself a very good choice; eight Indian carriers who were changed often, mostly because they ran away; two half-castes, rubber-collectors who attached themselves to the party for some time; and eight Rationales or semi-civilised Indians, with three women, and armed with Winchesters. It is customary, in most Latin-American countries, to distinguish as "reasonables" those Indians who have been broken in to the white man's ways; other tribes are *bravos, reduzidos,* and *manzos, i.e.,* still wild, broken, or tame.

The danger of these travels arises from the wild natives, who, not understanding the object of a white man's presence, think it best to kill him, provided there is a chance of doing so without danger to themselves. An attempt to clear up the fate of the French explorer Robuchon, lost in 1906, was unsuccessful. When possible, travelling was done by launch; that down and up the Japura river by canoe; but by far the greater part of the journeys was across country, and therefore the most difficult in every respect.

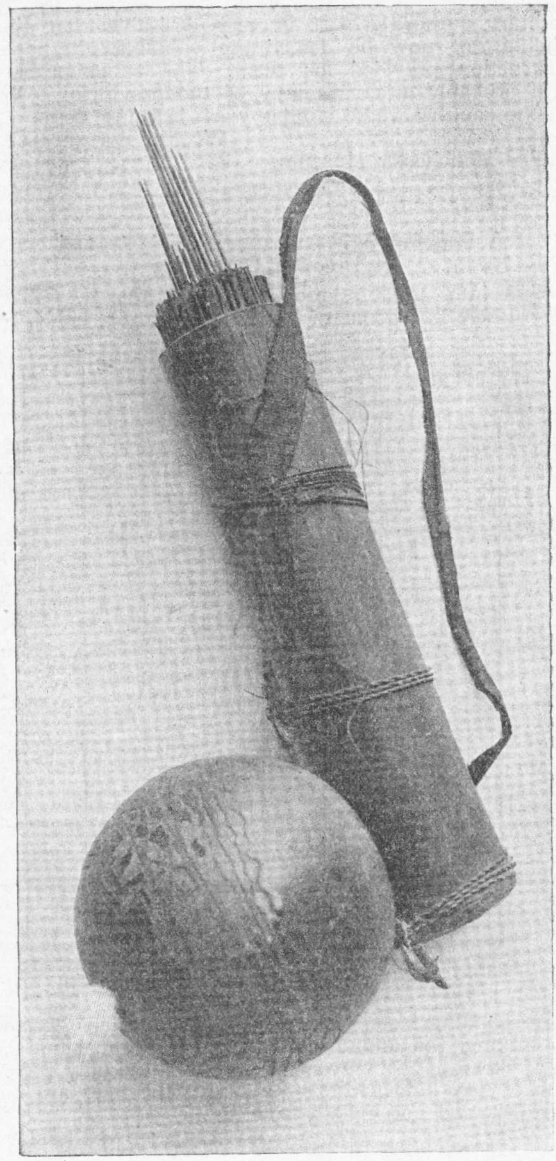


FIG. 1.—Andoke bamboo case with darts for blowpipe and gourd full of cotton. From "The North-West Amazons."

The seven months' travelling make an extremely complicated course.

Experienced traveller as he was, Captain Whiffen, in order to get an insight into the Indians' mode of life, sank all notions of superiority, manners, and customs, and practically lived their kind of life. Information could be obtained only by closest observation. The language is always the difficulty, and yet slurred over

[1] "The North-West Amazons. Notes of Some Months Spent among Cannibal Tribes." By Capt. T. Whiffen. Pp. xvii+319. (London: Constable and Co., Ltd., 1915) Price 12s. 6d. net.

by so many travellers' accounts, which give the impression as if they were the most accomplished of linguists. Our author, however, tells us upon what slender links his verbal information sometimes depended; English John, the negro, knew Witoto well, and one of the Witotos of the party knew a little Andotu, a tribe from which original information was wanted. In such a roundabout, laborious way some of the vocabularies and phrases published in the book had to be compiled.

Our traveller does not give a glowing account of the dreary monotony, discomfort, and ever-present danger in the bush, "the weary stretches of inundated country and sweating swamp, where you pass with an unexpected plunge from ankle-deep mire to unbottomed main stream. The eternal sludge without a stone or honest yard of solid ground makes one long for the lesser strain of more definite dangers or of more obtrusive horrors. The horror of Amazonian travel is the horror of the unseen. It is not the pursuit of unfriendly natives that wears one down; it is the absence of all sign of human life. Only the silent message of a poisoned arrow or a leaf-roofed pitfall tells of their existence somewhere in the tangled undergrowth." "Game being always hard to shoot in the bush, and fish, if plentiful, hard to catch, the real fear of starvation, after, perhaps, the ghastly dread of being lost, is the greatest cause of anxiety." The necessity of having to carry rifles and food (half of the tinned provisions turned out to be bad) forced him to travel without a tent!

The present book is not a story of travel, scenery, and adventure; in fact, not an account of what the author did, but a series of reports of observations concerning the natives in every respect—their physical conditions, mode of life, beliefs, folklore, languages, music, implements, customs; and most of the respective chapters are written and self-criticised from the wider point of comparison with other peoples of other lands, and thus this many-sided work will prove of great value to the student of anthropology. Only a few instances can here be mentioned. The Japura tribe carefully retain the teeth of the slain, to be made into necklaces as a visible and abiding token of accomplished revenge. This removal of the teeth may be held synonymous with the curse of many savage tribes in reference to their enemies, "Let their teeth be broken"; *cf.* also King David, and possibly the reason is a reversion in thought to the time when teeth were man's only weapon.

A large number of spider-monkeys were observed, with tails so prehensile that they served as additional hands to convey fruit to their mouths. Some tribes consider it beast-like, unclean, to eat birds' eggs, although they eat those of turtles and the combing of their own head-fauna. There is a tribal hot-pot over the chief's fire in the big communal house to which all the unmarried men must contribute, besides the individual family hot-pots. The newborn child is washed and ducked in the river; if it is not strong enough for this drastic treatment, it had better die; large families not being wanted, there is a vigorous weeding-out, after birth, females first.

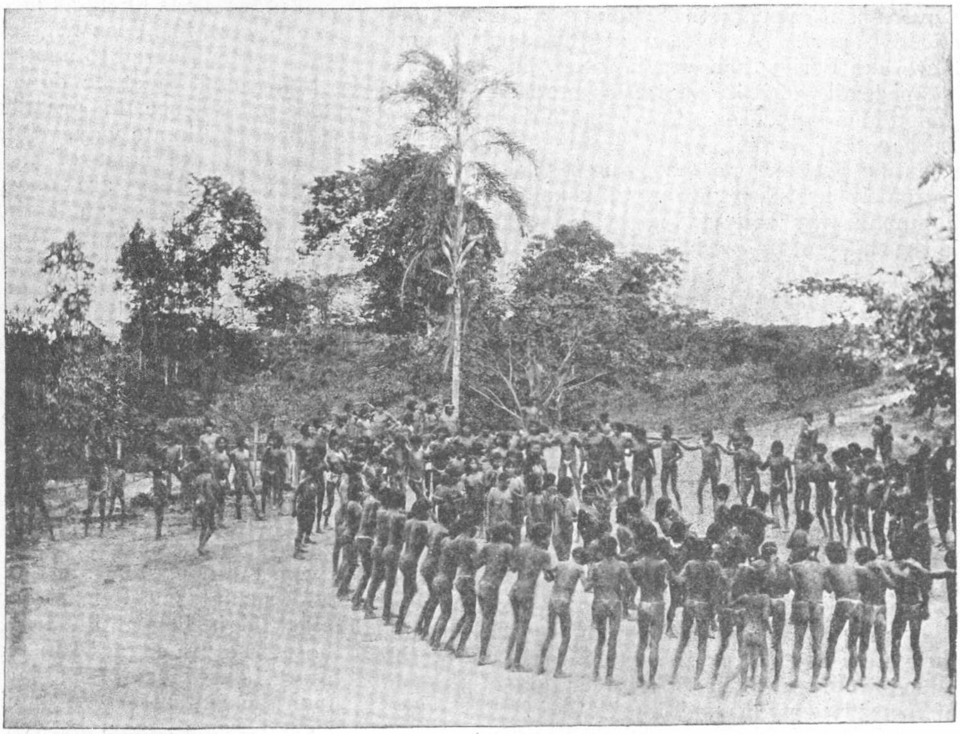


FIG. 2.—Okaina Dance. From "The North-West Amazons."

Besides a large map, and a small one for the chapter on languages and dialects of these very locally and sparsely populated wildernesses, the book is embellished with many, mostly excellent, photographs, which are a record of industry and patience where films proved useless on account of the moist climate. The groups of natives were always taken as they lived, according to climatic and psychological essentials, the women naked and often painted, the men unembarrassed by more than a loincloth.

THE AMERICAN STATE AND HOUSEHOLD SCIENCE.

THE application of science to national life and industry in the United States proceeds apace, and affords a very interesting spectacle in its variety of methods and experiments. Undoubtedly great progress is being made amidst a great deal of talk, and America bids fair to rectify itself in relation to science much more quickly than we can do even under the stupendous impact of war and all that it threatens to us. In this process of rectification the United States Government appears to be taking a discreet and effective part. A Bureau of Standards sounds more like Berlin than Washington, but the name is misleading if it suggests bureaucracy and punctilious standardisation. The circulars of the Bureau are, in fact, very careful and admirable scientific publications conveying a vast amount of extremely useful information, usually written in a human way and having behind them nothing in the shape of an act of legislature or compulsory standardisation. The Government gives a lead, it shows you something of which you may avail yourself; you may take it or leave it, but, at any rate, it is there. It is a calamity that we cannot say as much for our own country, where a Board of Trade hardly seems to understand what you mean when you ask it to embody a scientific element.

In one of its latest circulars[1] the U.S. Bureau of Standards enters upon a new path, attempting to reach the household:—"(1) To give information as to wants, methods, and instruments of measurement useful in household activities; (2) to describe available means of assuring correct quantity in articles bought by weight and measure; and (3) to give other facts of interest which would awaken an appreciation of the *rôle* of measurement in daily life."

Stress is laid on the educational value of such measurements and on the increase of efficiency in the household, which comes from the habit of thinking in terms of units and definite quantities. The introduction is indeed a temperate and admirable appeal for increased accuracy and better knowledge in the use of household appliances and in the conduct of household operations.

The substance of the circular is comprehensive. It includes chapters on commodities, heat, light, electricity, gas, water, atmospheric humidity, atmospheric pressure, density of liquids, time. In each case the trade and household measuring instruments related to these topics are carefully described both in principle and in mechanical detail, and excellent illustrations abound. There is an abundance also of useful hints directed towards securing efficiency and economy, and, in fact, the circular might be called in many respects a treatise on that ambiguous subject known as domestic science.

As such it suffers from a common defect, namely, the attempt to expound scientific principles piecemeal and incidentally, or parenthetically, to single applications. This kind of defect is always visited with severity by the more academic critics, but it may be urged that the defect is not so great as it seems. It is true enough that the contents of this circular, so far as they call for scientific comprehension, will be unassimilable by the ordinary mistress of the household who has only received the one-sided and largely unnegotiable gift of "a good general education." But it is equally true that the anchorage of sound scientific explanations to things and processes of the most obvious practical utility is as likely as anything to direct attention to what has been neglected in one generation and may be secured to another.

Something must be done to demonstrate the place of science in practical affairs, and this seems a legitimate way. Our educational masters seem to make most of their mistakes by forgetting that they are exceptional members of society in having an enthusiasm for abstract knowledge. No doubt the love of knowledge for itself exists to some degree in everyone, and may be developed; but the ordinary circumstances of the world make most people, even at an early age, want to know what use is to be made of knowledge. The fastidious exclusion of the useful from the exposition of the good and true is an unnecessary and fatal extravagance of the pedagogue, and nowhere has its incidence been more lamentable than in the case of natural science. Are we not at the moment bemoaning a nation that does not even know that science is useful? Who or what is responsible for this? Many answers are given, but none is nearer the truth than this: that our teaching has failed. How and where it has failed might be well illustrated by this circular, if those who are engaged in teaching science to the future housewives of England could be examined upon the contents. We should see the reason why such a gap remains between the science of our schools and science in actual use. There is a missing link. It is true of the domestic world, it is true of the industrial world, it is true of the whole national life, and there is urgent need of a remedy. The publication under notice helps to fill one gap, and it should be of real value to those engaged in teaching science to future housewives; and it will help also towards making boys' science more mobile in their homes.

A. S.

THE CLOSING OF MUSEUMS.

A PROTEST against the closing of museums (including art galleries) was made to the Prime Minister on February 10 by a deputation representing the Museums Association, the National Art Collections Fund, the Royal Asiatic Society, the Hellenic Society, the Art Workers'

[1] U.S. Department of Commerce. Circular of the Bureau of Standards No. 55. "Measurements for the Household."

Guild, and the Imperial Arts League. Mr. Asquith, emphasising the need for economy in every direction, explained that the Government had not accepted the recommendation of the Retrenchment Committee in full, since, in addition to the Reading Room of the British Museum, it had decided to keep open the National Gallery and the Victoria and Albert Museum. In view of the numerous colonial visitors and wounded soldiers who resorted to the Natural History Museum, a further concession might be made. "I have," said Mr. Asquith, "come to the conclusion that the portions of the museum which most interest ordinary visitors should remain open, but I do not think that the argument applies to the geological and mineralogical sections. In addition, I hold that facilities should continue to be offered to students at the museum." It was further made plain that the closing had nothing to do with the question of safety; also that the authorities of provincial museums were at liberty to do what they thought best. The galleries and the students' rooms (except that of Manuscripts) at Bloomsbury will be closed on and after March 1. As for the Natural History Departments, it remains to be seen which will be closed by the trustees as not interesting ordinary visitors.

We regret that the Prime Minister should have laid stress only on popularity, and should have paid no attention to usefulness. It is not always the most popular exhibits that are the most useful. Galleries left alone by the "ordinary visitor," *e.g.*, that of fossil invertebrates, are much frequented on certain days by collectors and students (not the "students" whom Mr. Asquith had in his mind). But, if popularity is to be the test, surely the Egyptian Department at Bloomsbury and the Fossil Mammal Gallery at South Kensington should not be closed. "Such limitations," said Mr. Asquith, "will last only for a time"; but on what the length of that time is to depend no indication has been given. Our leaders in all branches of intellectual study must be prepared for a struggle lest this action should prove a serious and permanent set-back to research and education, especially in the realms of science.

The following report of the speech made by Sir Ray Lankester as one of the deputation received by the Prime Minister will be of value to those who may be called upon hereafter to discuss this matter.

I am sure that we all agree as to the necessity for retrenchment in public expenditure and sympathise most heartily with the general purpose of the Government in this matter. But we think that the exclusion of the public from the national museums and picture galleries is not well advised, because it will result in a very small saving and a very great public loss. The widespread feeling against this closure has been made evident in the daily Press and by the support given to the present deputation. But I should not wish to urge this as decisive. We fully recognise that the Prime Minister may consider it to be necessary, however reluctantly, to effect this economy; our object is to state facts which seem to us to show that the advantages of such a course are altogether outweighed by the disadvantages. We think that the Committee on Retrenchment which has reported to the Government in favour of the closure of all public museums and galleries, excepting the reading-room of the British Museum, has not had the facts fully in view.

The great national museums and picture galleries are not mere shows. They, like the great cathedrals which stand always open, are places of rest and mental refreshment in this time of stress and anxiety. They are also a continual source of education and instruction which should not be abandoned even during war, except in case of dire necessity. Were they closed those who now frequent them would seek distraction in less worthy resorts.

It seems to many of us that, in regard to the question of closure of the museums, it is undesirable to make a rule of "all or none." Each case should be judged on its own merits. The saving of expense would be greater in one case than another, and the public disadvantage greater in one case than another. The Government, we are told, has recognised this, and has decided not to close either the National Gallery or the Victoria and Albert Museum.

I shall therefore confine my remarks to the case of the Natural History Museum, concerning which I have special knowledge, having been for some years its director. The Government does not propose to arrest the work which is done by the curators and other members of the staff in this and other museums. There is no suggestion that the collections should be allowed to deteriorate for want of proper supervision, cleaning, and protection from cold and damp. It is merely proposed to stop the free daily access of the public to the exhibition galleries of the museum. This would tend to a saving at the Natural History Museum of about 2000*l.* a year, and no more. It would be made by the reduction in the number of police and guardians employed in the public galleries. On the other hand, the building, the glass cases, and the specimens, together with the cost in the past thirty years of arrangement, preparation, and labelling of the exhibited specimens, represent a capital expenditure of not less than a million and a half pounds sterling, which, at 5 per cent., corresponds roughly to an annual sum of 75,000*l.* To this we must add the expenditure of an annual grant, voted by the House of Commons, of 45,000*l.* (reduced from 60,000*l.* to that smaller sum by special economies during the war), giving as the annual cost of the Natural History Museum to the nation a sum of 120,000*l.* It is proposed to exclude the public from this great and beautiful show in order to reduce the annual expenditure on it by one-sixtieth. This is recommended by the Retrenchment Committee as "an object-lesson in national economy." It is no doubt necessary to save small sums here and there in many directions of public expenditure. But it must seem to most people absurd to spend so large a sum on a splendid institution and then, for the sake of a relatively minute reduction of that expenditure, to sacrifice one of the main purposes—if not the main purpose—for which the great expenditure is made—namely, the public edification. It is a maximum of loss and injury to the public with a minimum of financial profit to the National Exchequer.

To obtain a small saving in this way by excluding the public, for whom it exists, from one of its most costly and valued possessions would, moreover, show not only an almost ludicrous misapprehension of the relative proportions of sacrifice and gain, but would be open to the objection that such action involves a breach of trust on the part of the Trustees, and is contrary to the Act of Parliament under which they exist. The money by which the Natural History

Museum has been built, fitted, and furnished, and that by which it is maintained in full efficiency, has been annually voted by Parliament, and generous benefactors have given priceless collections to it on the express understanding that the museum is—by Act of Parliament—a permanent national possession daily open to the public. It is, of course, understood that the Trustees may close it on certain days for administrative purposes, and in case of national disaster the Government would be justified in suspending all expenditure upon it. But the endeavour to save a minute fraction of the annual cost of the museum by hastilv closing its doors in its owner's face, must lead to public resentment and want of confidence in the Trustees, who alone (and not the Government) are by Act of Parliament distinctly charged with the public duty of keeping it open. As a consequence there might very probably be a resistance in Parliament to the passing of the annual grant by which the museum is maintained, and the good work done there might be curtailed or brought to an end.

It has long been the policy of those who have duly understood the position of the Natural History Museum to give every facility and every assistance to the public in the use and enjoyment of its contents. It was the main care of Sir William Flower when director to make the galleries both delightful and really educative. In that respect I, in my turn, followed him, and recognised as a fundamental principle of administration that the public must be enabled, in every possible way, to understand and to enjoy the great museum for which it pays. That is no more than a fair and honourable acknowledgment to the taxpayer of the large sums which his Parliamentary representatives (quite independently of the Government of the day) place in the hands of the staff of the museum for the purpose of scientific research and discovery and the maintenance of the museum as a centre of study and expert advice. It is only by securing for it the intelligent interest and appreciation of the public that the Natural History Museum can be assured of the continuance of its annual subsidy. That view, I may say, was one which was often expressed to me by our late King Edward, when, as Prince of Wales, he was a trustee of the museum. It seems to me that to shut the public out of its museum in order to spare expenditure on the wages of a few superannuated soldiers as watchmen, would be to give public offence without any prospect of compensating advantage, and I therefore venture to hope that the proposal to do so may be reconsidered.

An error, for which we were not responsible, crept into the figures of attendance at the Colchester Corporation Museum, to which we alluded last week. The week-day figures for the last nine months of 1915 were 39,933. But, even so, the numbers seem to have been quite double those of ordinary years.

NOTES.

WE announce with deep regret the death on February 15, in his eighty-fifth year, of Sir William Turner, K.C.B., F.R.S., principal and vice-chancellor of the University of Edinburgh.

WE see with much regret the announcement, in the *Times* of February 11, of the death of Prof. I. P. Pavlov, a foreign member of the Royal Society, late professor of physiology in the University of St. Petersburg, and director of the Imperial Institute for Experimental Medicine.

SIR E. VINCENT EVANS has been appointed chairman of the Royal Commission on Ancient Monuments in Wales and Monmouthshire, in succession to the late Sir John Rhys.

THE death is announced, in his sixtieth year, of Dr. J. O. Reed, who had been connected with the University of Michigan since 1892, as successively, instructor, assistant professor, and professor of physics. He was the author of a text-book of "College Physics," and, with the late Prof. K. E. Guthe, of a "Manual of Physical Measurements."

ACCORDING to the *British Medical Journal,* the foundation-stone of the Hospital for Tropical Diseases of the Calcutta School of Tropical Medicine will be laid on February 24 by Lord Carmichael, the Governor of Bengal. We learn from our contemporary that the whole of the money required for the building has now been collected.

AT the meeting of the Prehistoric Society of East Anglia on February 7 Mr. J. Reid Moir read a paper on Palæolithic implements found at Darmsden, Suffolk, in a high-level plateau deposit. Some are choppers or scrapers, while others appear to have been used as borers. All have been made from Lower Eocene pebbles, and appear to represent a hitherto unrecognised type.

AMONG the goods of which the import is prohibited by a Proclamation to come into force on March 1, are:—All materials for the manufacture of paper, including wood pulp, esparto grass, and linen and cotton rags; paper and cardboard (including strawboard, pasteboard, millboard, and wood pulp board), and manufactures of paper and cardboard; and all periodical publications exceeding 16 pages in length, imported otherwise than in single copies through the post.

THE committee of the Privy Council for Scientific and Industrial Research has appointed the Hon. Sir C. A. Parsons, K.C.B., F.R.S., to be a member of the Advisory Council in place of Prof. B. Hopkinson, F.R.S., who has been forced to resign by the pressure of his military duties and special work connected with the war. The committee has also appointed Prof. J. F. Thorpe, F.R.S., to fill the vacancy on the Advisory Council caused by the death of Prof. Raphael Meldola, F.R.S.

ACCORDING to the Cape Town correspondent of the *Times* (February 11), the Rand has been subject to a series of earth-tremors, which have lately been increasing in frequency and strength. A committee appointed to investigate them has issued a reassuring report. The shocks, it appears, are purely local, being the result of mining operations, and therefore unlikely ever to be of a destructive character. They seem to resemble the earth-shakes which are not uncommon in the mining districts of this country, and are probably due to small movements along faults precipitated by the withdrawal of coal or water.

THE *Nieuwe Courant* of February 3 announces the death, from heart failure, of Dr. August Michaelis, professor of chemistry in the University of Rostock.

Dr. Michaelis published numerous papers on organic derivatives of phosphorus, arsenic, antimony, and of other elements. His first paper in the *Berichte*, on phosphorus sulphobromide, dates back to 1871, and almost his last was a long paper on organic compounds of phosphorus and nitrogen, in the *Annalen* of last year. He was successively connected with the technical high schools of Karlsruhe and of Aix-la-Chapelle, and had been for the last twenty-five years at Rostock.

THREE volumes of special reports on the mineral resources of Great Britain, prepared by the director of the Geological Survey in response to numerous inquiries that have arisen through the conditions brought about by the war, have just been published. In vol. i. the uses, distribution, treatment, and output of tungsten and manganese ores are dealt with, and particulars of the mines, active and inactive, are given. The second volume deals with the sources, uses, and treatment of barytes and witherite (the sulphate and carbonate of barium). The mines from which the minerals are or have been raised are described in detail. Vol. iii. of the series deals with the properties, uses, treatment, and modes of occurrence of gypsum, anhydrite, celestine, and strontianite. Details of the workings in all parts of Great Britain are given, with statistics as to output. Copies may be obtained through any bookseller, or from the Director-General, Ordnance Survey Office, Southampton.

ONE of the most talented and promising of our young botanists was lost to science on January 5, when Capt. A. S. Marsh, of the 8th (Service) Battalion, Somerset Light Infantry, was shot through the heart by a German sniper on the western front. We are indebted to Mr. A. G. Tansley for the following particulars of Capt. Marsh's career and work:—Marsh was born at Crewkerne in 1892, and was educated at Sexey's School at Bruton. He began residence at Trinity College, Cambridge, in 1909, took the first part of the Natural Sciences Tripos in 1911, and the second part in 1913, and was placed in the first class in both parts. In 1913, also, as a result of getting a Frank Smart studentship in botany, he migrated to Caius. Marsh demonstrated in the elementary botany and elementary biology classes at Cambridge and also in Dr. Moss's field classes. The vigour with which he devoted himself to military work, his evident success with his men, and his popularity among fellow-officers perhaps surprised some of his friends, for Marsh had seemed essentially a student. He published four botanical papers:—"Notes on the Anatomy of *Stangeria paradoxa*" (*New Phytologist*, January, 1914); "The History of the Occurrence of Azolla in the British Isles and in Europe generally" (Proc. Camb. Phil. Soc., February, 1914); "The Anatomy of some xerophilous species of Cheilanthes and Pellæa" (*Annals of Botany*, October, 1914); and "The Maritime Ecology of Holme-next-the-Sea, Norfolk" (*Journal of Ecology*, June, 1915). All his papers showed marked ability, and the most important—a study of the salt marsh near Hunstanton—is a piece of work admirably conceived and executed. Before he left Cambridge, also, he devised some ingenious experiments in competition between closely allied species of plants which in nature occupy different habitats, and these were beginning to give valuable information on the ecological relations of the species. But at the time he joined the Army, Marsh was only just beginning to "find himself" intellectually, and it is impossible to say what he would have done in science if he had lived to return to botanical work. He was very greatly loved by those who knew him best, and his death is a bitter loss to his friends.

IN *Man* for January Prof. Ashby describes the excavation of a portion of a megalithic building in Malta, known as Id-debdieba, "The Place of the Echo." Among the objects discovered were six pillars of hard coralline limestone, cylindrical in shape, but some tapering at one end, of a type common in Maltese megalithic buildings; a few flint implements; a quantity of Neolithic pottery, with other fragments showing that the site was occupied in Greek and Roman times.

IN the American *Museum Journal* for December last Mr. H. Lang describes, with a fine set of photographs, his work of exploration in the Congo valley. He points out that the result of the present war will be even more disastrous to these native races than to the peoples of Europe. The direct loss of life will be largely confined to the white officers; but the dispersal of hosts of armed native warriors when the hostilities are over will inevitably lead to a wide extension of the dreaded plague of sleeping sickness. The usual prophylactic measures have been seriously weakened as a result of the war, and there is little hope of checking the plague in the absence of a well-equipped medical service entailing enormous expenditure, for which the necessary funds cannot be provided.

THE always interesting problems on motion raised by Zeno, and continued at recurrent intervals ever since, form the text of an amusing article, "The Flying Arrow," by P. E. B. Jourdain, in *Mind* (New Series, No. 97). The shade of Zeno is represented as being conversant with all the mathematical and philosophical works, including the periodic literature, since his day, and with Socrates as his victim and auditor he analyses critically those who have wrestled with his paradox of the flying arrow. The writer's view is that all four arguments are directed against the belief that lines are made up of points. Both philosophers and mathematicians will find the article stimulating and subtly amusing.

THE twenty-ninth annual report of the Liverpool Marine Biology Committee, in addition to the usual accounts of work at the Port Erin Station, contains an address by Prof. W. A. Herdman on the life and work of Edward Forbes. Reading this vivid account of an arduous and fruitful career, the naturalist of to-day cannot but mourn the loss which biological science suffered from Forbes's early death in 1854, a few months after he had attained "the goal of his ambition, the chair of natural history at Edinburgh." Prof. Herdman's appreciation of Forbes's work is wise and generous, yet present-day students of distribution will consider that less than justice has been done to Forbes's classical Survey Memoir on the fauna and flora of the British Isles. So far from "the three southern subfloras of Forbes in place of being the oldest, as he supposed," being now known to be the most recent, the relatively high antiquity at least of Forbes's Lusitanian flora has been confirmed by much recent work on the natural history of Ireland and western Britain.

SOME interesting observations on the physiology of frogs are recorded by Messrs. A. T. Cameron and T. I. Brownlee in the *Quart. Journ. Exp. Physiol.*, vol. ix., No. 3. It is well known that frogs will endure prolonged submersion in water, efficient respiratory exchange going on through the skin. The authors find that with *Rana pipiens* in Manitoba, the average time for which the animal will live under water is sixteen days, with an observed maximum of fifty-two days. Death from too prolonged immersion is preceded by swelling, due partly to absorbed water, but largely to accumulation of absorbed nitrogen. In another paper these authors discuss the upper limit of temperature compatible with life in the frog. They had previously fixed the lower limit at approximately 1·25° C. below freezing point. They now find that *R. pipiens* cannot live for more than a few days submerged in water at 18° C., and that a few minutes' endurance of a temperature of 35° proved fatal. In damp air similar results were obtained, but the high-limit temperature requires longer to cause death. The internal temperature of the animals scarcely differs from that of the medium, and can evidently vary only within the limits mentioned if life is to be maintained.

To determine whether selection, or mutation, is the more important agency in evolution, Prof. W. Castle some time ago started a series of experiments with hooded-rats, since these afforded him the single genetic factor necessary for his investigation. A very careful analysis of the data accorded him after breeding 33,249 rats, excluding those which formed the subject of "control" experiments, seems to demonstrate clearly enough that "there is apparently no limit to the quantitative change which can be produced in the hooded pattern by selection, short of its complete extinction in the all-white, or all-black condition." This being so, then "two foundation postulates of the mutation theory are false, viz.: (1) that continuous, or graded variations, are not concerned in evolution, and (2) that selection of such variations, no matter how long continued, can effect no permanent or progressive racial changes. Selection, as an agency in evolution, must then be restored to the important place it held in Darwin's estimation, an agency capable of producing continuous and progressive racial changes." Prof. Castle states his case with remarkable lucidity in the *Scientific Monthly* for January, numerous diagrams contributing not a little to the value of this most important summary.

IN *Knowledge* for January Mr. Aubrey Drew discusses some cytological problems raised by recent cancer research. He first describes the "jelly method" of *in vitro* staining of cells, devised by H. C. Ross. An agar jelly is made, and to this sodium chloride, sodium citrate, and citric acid are added in certain proportions, and afterwards sodium bicarbonate and Unna's polychrome methylene-blue in quantities varying with the cells to be examined. For use the mixture is melted, and a drop or two placed on a slide and allowed to set. A little of the material to be examined is then placed on the jelly, covered with a cover-glass, incubated if necessary, and examined microscopically. In this way cells, such as leucocytes, can be seen dividing, and the changes in structure observed. Certain substances are found to be necessary for cell-division to take place, and are termed "auxetics," others increase cellular movements, "kinetics," and some of the latter increase the activity of auxetics and are termed "augmentors." These substances may play a part in cancer production. Thus certain auxetics and kinetics will produce tumours on injection into animals. Workers in pitch and tar are liable to be affected with cancer, but it is only gasworks pitch and not blast-furnace pitch which predisposes to cancer. By the jelly method it has been shown that gasworks pitch and tar contain both auxetics and kinetics (augmentors), but the blast-furnace products contain only traces of auxetics and no kinetics.

WE have received a copy of the list of seeds of hardy herbaceous plants and of trees and shrubs which for the most part have ripened at Kew during the past year. This annual publication, forming the first appendix of the Kew Bulletin for 1916, is a welcome sign that despite great difficulties owing to the depletion of the garden staff, the true functions of a botanic garden are being successfully carried on at Kew.

THE Journal of the Royal Horticultural Society for December, 1915, contains an interesting and very well-illustrated paper by Mr. G. Forrest on the flora of north-western Yunnan. The plates are from Mr. Forrest's own photographs, and include remarkably beautiful studies of several of the peculiar species of Primula found in this region. The Rhododendrons are also represented by numerous species, several being dwarf alpines, which form regular "heaths." Of these *R. prostratum* grows up to an altitude of 16,000 ft. Many of the Rhododendrons were found on pure limestone rocks, but whether they are really growing with their roots in the limestone rocks or in pockets of humus was not definitely determined.

COCONUT cultivation, though still a small industry in Queensland, is rapidly extending. Hitherto it had been supposed that copra from Queensland coconuts did not contain enough oil to be of commercial value, but the examination of a sample of copra from these nuts at the Imperial Institute has now established that the oil content is normal and the copra of good quality, and brokers state that shipments would be readily saleable in this country at good prices. Before the war the bulk of the copra shipped to Europe from Ceylon, India, and elsewhere was crushed in Germany and France. Urgent representations on this subject were made by the Imperial Institute on the outbreak of war to the oil-seed crushing firms in the United Kingdom, some of which have now begun to work copra, with the result that there is a new and good

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market for the product in this country, which is likely to expand when the new factories now building start work.

STUDENTS of petrography will note the description of three Indian meteorites by J. Coggin Brown ("Records Geol. Surv. India," vol. xlv., 1915, p. 209), the falls of which were actually observed between 1902 and 1914. All are referable to the prevalent sporadosiderite type, and show marked chondritic structure.

A SECOND edition of "The Geology of the Country between Whitby and Scarborough" has been issued by the Geological Survey of Great Britain (1915, price 2s. 6d.). It is practically a new work, and the description of the strata by the late C. Fox-Strangways and G. Barrow has been supplemented by a chapter by S. S. Buckman on their palæontological classification. The critical revision of the species and genera of ammonites will be very welcome to those who first examined the Whitby coast when far less exactitude prevailed. Considering how many visitors to this part of Yorkshire become here attracted for the first time to geology, we might suggest the insertion in a third edition of plates showing some of the most common forms, and the suture-lines that can be traced on rubbing down the surface of good specimens. Popular works on the Whitby district are obtainable, such as that by L. Walmsley (NATURE, vol. xciii., p. 382); but the Geological Survey is not sufficiently recognised as a powerful help in public education. The present memoir is further strengthened by a review of the glacial geology by G. W. Lamplugh.

NEARLY two years have elapsed since the circumstances of the loss of the *Karluk*, the ship of Stefansson's Arctic Expedition, were announced, but a full account of her voyage and her drift in the pack, and the escape of her crew after the sinking of the vessel, have so far been lacking. Captain R. A. Bartlett's diary from his departure from Nome to his return to Esquimalt is now published in full in the report of the Department of the Naval Service for the year ending March 31, 1915 (Ottawa). It is accompanied by a sketch map showing the drift of the *Karluk* from near Flaxman Island, where she was caught on August 12, to her destruction on January 11, north of Herald Island. The diary is characteristically brief, but it shows with what ability Captain Bartlett was prepared to handle the situation. Had all the members of the expedition taken his advice, there would probably have been no loss of life. Captain Bartlett wisely decided to bivouac on the ice for several weeks in order to harden the men and to get a track made over the rough ice by the time the light conditions improved. A road was prepared and depôts of provisions laid down, with the result that Captain Bartlett's party reached Wrangell Island in safety. How Captain Bartlett crossed to the mainland and ultimately returned from Nome with help has been told before. Unfortunately, there is now no hope of the safety of Dr. Forbes Mackay, Mr. James Murray, M. Henri Beuchat, and those members of the crew who accompanied them in their independent attempt to reach the land at an earlier date.

THE council of the Röntgen Society has drawn up and issued with the January number of the journal of the society a number of recommendations for the protection of X-ray operators. They are printed on a card, which should be suspended in a prominent position in every X-ray laboratory. In the early days of the therapeutic use of the rays many cases of X-ray dermatitis occurred, but these injurious effects may now be readily avoided. The X-ray bulb should be enclosed in a box lined with sheet lead two millimetres thick, and provided with an opening through which alone the rays required can emerge. The observer should protect himself with sheet lead of the same thickness, or with gloves or lead glass screens with an equivalent amount of lead in them. The efficiency of each screen should be tested before it is brought into use.

THE director of the Bureau of Standards at Washington gives a short account of the recent work done by the bureau in the January number of the Journal of the Franklin Institute. We have already given in these columns the results of the inquiry into the cause of the failure of fusible tin boiler plugs, and the investigation of the permissible variations in the method of manufacturing bronzes. Amongst the other subjects under investigation at the present time are:— The best platinum alloy for platinum ware, the causes of failure of wheels, rails, and other railway materials, the standardisation of test steel ingots, the distribution of the carbon in steels, the preparation of pure iron, the manufacture and properties of non-ferrous metals and alloys, and the causes of failure of structural brasses. It is impossible to read a list of investigations like this without feeling that the United States Government is providing a sound scientific basis for her industries, and that the money required for maintaining the bureau is well spent, or, we should prefer to say, well invested.

"SELLING Machinery by Motion Pictures" is the title of an article in the *Engineering Magazine* for January. Machines are generally too large to be sent for inspection by the prospective customer, and experience shows that it is very difficult to persuade him to visit the works where the machines are made. Many firms are now making a speciality of portable kinematographs, light in weight, small in size, and easy to operate. These can be connected to the lighting circuit in the customer's office with a blank wall as the screen, and the films show the mode of operation and construction of the machine in an ideal manner from the business point of view. The motion picture obliterates the seasons, and the action of a harvester can be shown in winter as easily as that of a planter in autumn. The article gives many instances of the use of the kinematograph for business purposes, and includes copies from parts of several typical films.

THE use of dry blast in the manufacture of iron and steel is discussed in *Engineering* for February 11. At least five plants have been installed in Great Britain; most of these have not been considered to yield a sufficient return for the outlay involved. Two plants erected in Germany were shut down after twelve months' running. On the other hand, the installation at the works of Messrs. Guest, Keen, and Nettlefolds, Cardiff, shows a saving in fuel of 13·4 to 18·4 per cent. Most of the American plants have effected notable economies, varying from 10 per cent. saving in fuel and 12 per cent. increase in output, up to 20 per cent. saving and 20 per cent. increase. The explanation of these divergent results is to be found either in the variation in local conditions, or in differences of practice. In practice refrigeration is the system almost universally used. The desiccation of the blast by calcium chloride, which is the only alternative, is less costly as regards initial outlay, but it is probable that the running costs would be much higher. Typical refrigerating plants are described in the article.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—The following preliminary elliptic orbit has been calculated by F. J. Neubauer and H. M. Jeffers, of the Berkeley Astronomical Department (Lick Observatory Bulletin No. 276):—Perihelion, 1916, January 27·906 G.M.T., $\omega=342^\circ\ 54'$, $\Omega=114^\circ\ 52'$, $i=14^\circ\ 30'$, $\log a=0{\cdot}48282$, period 5·299 years.

The Copenhagen ephemeris for this comet proves to represent its positions very accurately. The large corrections given in this column on January 27 were in error; actually the differences were insignificant. An observation made at Bergedorf on February 1, and forwarded by Prof. E. Strömgren, shows that the corrections then required were only -3s. in R.A. and $0'$ in declination.

SECONDARY NUCLEI OF COMET 1915*a* (MELLISH).—A series of photographs taken with the Franklin-Adams star camera at Johannesburg are reproduced in Circular No. 31 of the Union Observatory. The subsidiary nuclei were found to lie on a line almost tangential to the coma and not axially. On June 10 the brightest secondary was $82''$ distant, and another about $154''$. The line joining these nuclei was in position angle, 228·8°. Other measures of the nuclei are given by Mr. Melotte in the *Observatory* for January.

ON THE MEAN DISTANCES AND LUMINOSITIES OF STARS OF DIFFERENT SPECTRAL TYPES.—Prof. C. V. L. Charlier has investigated statistically (*Meddelande, Lunds* Astronomical Observatory) the mean parallax of stars according to spectral type in relation to mean distances and luminosities for all stars down to mag. 6·0. It is found that the β stars deviate only slightly from the mean absolute magnitudes of these stars, whereas the K—and still more the M—stars are characterised by great fluctuations about their mean absolute magnitudes.

ANOMALOUS DISPERSION IN THE SUN.—The suggestion advanced by Julius that anomalous dispersion could be the cause of small alteration in wave-length of neighbouring Fraunhoferic lines was followed by a notable research leading to confirmatory results (NATURE, September 2, 1915). This work is now sharply criticised by Mr. Evershed in a letter to the January number of the *Observatory*, and by Dr. Royds (Kodaikanal Observatory Bulletin, No. xlviii.) Small wave-length shifts between sun and laboratory sources have been the subject of much minute investigation at Kodaikanal during the past few years by direct measurement on large-scale spectrograms, and data derived from these studies now enable Dr. Royds to state that when the actual sun-minus-arc displacements are substituted for Albrecht's residuals the relative shift between the two groups of solar lines having a close companion on one side or the other is too small to establish anomalous dispersion in the sun. Evershed considers the case of close solar doubles. The effect of anomalous dispersion should be to increase the separation to a measurable degree as compared with the arc, but this is not found to be the case. Nevertheless it is recognised that it is difficult to explain away the grouping according to sign of the residuals in Albrecht's investigation.

BRITISH PRODUCTION OF SYNTHETIC DYES.

IN the *Times* of February 11 a Leeds correspondent comments on current developments of the problem of increasing the production of synthetic dyes. Whatever criticisms may be advanced against the Government scheme, it cannot be denied that the appointment of Prof. W. H. Perkin, the eldest son of the discoverer of mauve or aniline purple, to be head of the research department of British Dyes, Limited, is a most welcome augury of future progress. It is, however, a debatable point whether this department, endowed by the State to the extent of 100,000*l.*, ought in the public interest to be the monopoly of a single company, which under a new name and with the aid of a large Government subsidy is carrying on the business of one only of several competing firms.

The burning question of a year ago as to the desirability or otherwise of having chemists on the directorate of a colour works has now received a striking practical illustration in the less advertised developments recently effected in the firm of Messrs. Levinstein, Limited, of Blackley, near Manchester. In accordance with the best traditions of the Manchester school of economics, this firm of colour-makers, which practises the doctrine of self-help, has made very considerable extensions of its old-established works under the skilled guidance of their director, Dr. H. Levinstein, a college-trained chemist, a double graduate in science of the Universities of Manchester and Zürich, and a former pupil of Profs. Bamberger and W. H. Perkin. Without extraneous help, the Manchester firm has now to compete for home and foreign trade and for scientific assistance against a commercial rival enjoying preferential treatment from the State. It is obvious that the latter firm anticipates a further extension of favours from the Government, otherwise it would not be practicable to develop so large an area as a 250-acre site with the existing capital and with the comparatively small sum paid up by shareholders who are dye-users. A continuance of this policy of subsidies to one firm will handicap still further the meritorious efforts now being made by other less favoured undertakings.

The research work on dye production carried out in the dyeing department of the University of Leeds, under the auspices of the Board of Trade, by Profs. Green and A. G. Perkin and Dr. Oesch, formerly of the Berlin Aniline Company, is of the utmost importance in regard to the progress of the dye industry in this country. But if the effort to recover our lost supremacy in dyes is to be truly national the benefits of this university research should, at least to some extent, be at the disposal of other dye-producing works besides the exceptionally favoured successors of the old Huddersfield firm.

THE DAILY FOOD RATION OF GREAT BRITAIN.[1]

SEVERAL estimates of the food supply of Great Britain, in whole or in part, have been published in recent years. But in none of these has a computation been made of the "foodstuffs" contained in the food, or of the energy which it furnishes to the human body. Yet these are the only standards which apply to all foods, whether solid or liquid, and taken together constitute the only applicable test by which the supply can be properly gauged. Thus we can only say whether the supply is sufficient, excessive, or deficient, when we know the quantities of protein, carbohydrate, and fat, and the amount of energy it provides per day to the consumer. Further, it is only when we have this knowledge that we can intelligently proceed to substitute articles of diet for others which may have been cut off or rendered scarce from any cause.

Such a survey of the food supply of Ireland has recently been made by the writer, and it seemed desirable that a corresponding inventory should be taken of that of Great Britain.

To do this, an independent estimate had in the first instance to be made of the total food of the country, both imported and home produced. This could only be done, with any degree of accuracy, for one particular year, that of the "Census of Production." So far the results of only one such census have been published, namely, for the year 1908. Accordingly the survey applies to this particular year; but there is every reason to suppose that it would apply equally well to any year of the last decade. The returns from which the quantities of the different food materials have been made are:—(1) Those of the Board of Trade, which give the imports and exports; (2) those of the Board of Agriculture, which give the home supplies; (3) those of the Departments of Fisheries of England, Scotland, and Ireland, which give the fish landed; and (4) lastly, those given in the Final Report of the First Census of Production, which supplement the others in necessary ways.

The Food Supplies.

These were collected under the following heads, namely:—(1) Cereal foods; (2) vegetables; (3) meat; (4) fish; (5) dairy products, eggs, margarine; (6) fruit; (7) other foods. It is only possible to give here short summaries of the estimates.

(1) *Cereal Foods.*—These include wheat flour and meal, oatmeal, rice, barley flour, maize meal, and "other farinaceous foods." The total supply is made up as follows:—

Net imports	Home produce	Total
67,506,951 cwts.	23,395.795 cwts.	90 902,746 cwts.

That is to say, 74 per cent. of our cereal food supply is imported and 26 per cent. home grown.

(2) *Vegetables.*—In this category are included potatoes, onions, tomatoes, cabbage and other green vegetables, carrots, beet, turnips, parsnips, celery, rhubarb, peas, and beans. The supplies are as follows:—

Net imports	Home produce	Total
16,360,000 cwts.	94,423,640 cwts.	110,783,640 cwts.

That is to say, 15 per cent. of our vegetables are imported and 85 per cent. home grown.

(3) *Meat.*—The supplies comprise beef and veal, mutton and lamb, pork, bacon, and hams, poultry, game, and rabbits, sausages and "offal." It is needless to say that all imported meat, including frozen, refrigerated, salted, and tinned has been included. The following are the quantities:—

Net imports	Home produce	Total
25,886,471 cwts.	24,577,994 cwts.	50,464,465 cwts.

Thus in round numbers 51·5 per cent. of the meat supply of Great Britain is imported and 48·5 per cent. home produced, Ireland being considered an importing country. Lard is not included in this list. It is given with imitation lard in Group 7, "Other Foods."

(4) *Fish: (a) Fresh, (b) Cured and Preserved.*—The fresh fish included herrings, cod, ling, haddock, mackerel, whiting, pollack, salmon, eels and congers, turbot, other flat and miscellaneous fish. Oysters and shell-fish were omitted. The cured and preserved fish included sardines, salmon, other sorts canned, and other sorts not canned. After making allowance for fish exported, the following are the net supplies:—

Fresh fish	Cured fish	Total
12,692,530 cwts.	591,802 cwts.	13,284,332 cwts.

(5) *Dairy Products, etc.*—This group includes butter, cheese, milk and cream, condensed milk, eggs, and margarine. The following are the quantities:—

	Net imports	Home produce	Total
Butter	4.834,722 cwts.	690,000 cwts.	5,524,722 cwts.
Cheese	2,207,459 cwts.	573,000 cwts.	2,780,459 cwts.
Milk and cream	63,710 gals.	802,439,000 gals.	802,502,710 gals.
Condensed milk	1,113,087 cwts.	—	1,113,082 cwts.
Eggs	24.609,266 gt. hunds.	9,494,084 gt. hunds.	34,103,350 gt. hunds.
Margarine	814,854 cwts.	881,000 cwts.	1,695,854 cwts.

There are reasons for believing that the quantity of home-produced cheese given in this list (as taken from the agricultural returns) is considerably below the actual consumption. The returns do not give any estimate of the farm produce consumed by the agricultural population. The home supply of eggs is also below the actual, since the returns do not include produce from farms below one acre. It is estimated that one-third of the total eggs are supplied by small poultry-keepers. Taking the quantities in the table above, it would appear that the home produce of butter from Great Britain, excluding Ireland, furnishes only 12·5 per cent. of the total supply, that of cheese 21 per cent., that of eggs 28 per cent. It is certain, however, that these two last estimates of home supply are well under the mark, and if the whole in each case were included, it is probable that the home supply of cheese consumed would be 35 per cent. and of eggs 42 per cent. of the total. Taking the home supply, however, even at these last values, it is not consoling that we have to rely so much on imports for what could apparently be produced without difficulty at home, in much larger quantities than at present.

(6) *Fruit: (a) Fresh, (b) Dried and Nuts.*—Of fresh fruit the returns give the quantities of apples, pears, oranges, lemons, bananas, plums, cherries, small fruit, other kinds and nuts. The following are the total supplies:—

Net imports	Home produce	Total
16,810,154 cwts.	6,044,250 cwts.	22,854,404 cwts.

Of this total, apples, oranges, and bananas make up three-fourths, and approximately in equal quantities. Of the home supply, apples make up two-fifths, but this does not include apples used for making cider.

The list of dried fruits and nuts includes currants, raisins, figs, dates, fruit preserved with sugar, almonds, coconuts, Brazil nuts, and walnuts. The total

[1] Abridged from a communication to the Royal Dublin Society, October 26, 1915, entitled, "A Calculation of the Food Stuffs and Energy of Great Britain's Food Supply."

quantity amounts to 3,057,789 cwts., of which currants make up one-third and raisins one-fifth.

(7) *Other Foods*.—In this category are included sugar, glucose, molasses, caramel, cocoa, chocolate, and olive oil. The following are the quantities:—

	cwts.		cwts.
Sugar	27,718,420	Cocoa and chocolate	549,050
Glucose (as dry sugar) ...	1,836,820	Lard and imitation lard	2,570,664
Molasses... ...	2,199,515	Olive oil	82,800
Caramel ...	149,000		

The "Food Values" of the Supply.

When the food values—that is to say, the foodstuffs and energy values—of the previous supplies are reckoned out, it is found that for the year 1908 the population of Great Britain (40,200,000) was provided with the following amounts, of which the particulars are given in Table I.:—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)[2]
2,419,166,767	14,175,125,520	3,231,594,600	44,826,291,359

and avoid duplication in allocating the supplies, it was assumed that those engaged in agriculture, together with their families, were self-provided with most of the foods grown on the farms. Accordingly, the foodstuffs and energy derived from the following list of farm produce were distributed, not amongst the whole population, but amongst those left after the agricultural population had been deducted. This list included:—(1) Vegetables (namely, potatoes, onions, cabbage, root crops, green peas, and beans); (2) dairy produce (namely, butter, cheese, milk, cream) and eggs; (3) oatmeal and barley flour; (4) poultry, game, and rabbits; (5) certain fruits (namely, apples, pears, plums, cherries, together with one-third of the small fruit).

The food values reckoned out for those articles and divided amongst the balance of the population left, after deducting for the agricultural population, are as follows:—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)
728,697,739	2,835,356,188	1,083,718,635	11,492,106,905

TABLE I.—*The Foodstuffs and Energy Value of the Supplies.*

Food cwts.	Protein (lbs.)	Per cent. of total	Carbohydrate (lbs.)	Per cent. of total	Fat (lbs.)	Per cent. of total	Energy value Kilo-litre calories	Per cent. of total
Cereals	812,319,670	33·57	7,691,559,440	54·26	166,164,825	5·14	16,529,418,461	36·87
Vegetables ...	254,084,030	10·50	2,063,138,585	14·55	25,619,770	0·80	4,536,494,297	10·12
Meat	765,107,322	31·62	2,000,630	0·01	1,522,946,045	47·14	7,864,180,633	17·55
Fish	122,922,445	5·08	—	—	21,039,865	0·64	331,774,867	0·73
Dairy produce, etc.[3]	419,152,920	17·35	470,009,535	3·32	1,445,040,540	44·72	7,865,591,882	17·56
Fruit—								
(*a*) Fresh ...	14,390,455	0·59	285,095,825	2·01	7,031,610	0·22	597,242,464	1·33
(*b*) Preserved and nuts ...	12,368,895	0·51	166,588,475	1·17	17,603,390	0·54	458,507,190	1·02
Other foods ...	18,821,030	0·78	3,496,733,030	24·68	26,148,555	0·80	6,643,081,565	14·82
Total ...	2,419,166,767	100·00	14,175,125,520	100·00	3,231,594,600	100·00	44,826,291,359	100·00
Divisible into:								
(*a*) Agricultural	728,697,739		2,835,356,188		1,083,718,635		11,492,106,905	
(*b*) General ...	1,690,469,028		11,339,769,322		2,147,875,965		33,334,184,454	

To obtain a proper conception of the adequacy of the supplies, these totals have to be divided, not by the whole population, but by the man-value of the population. It is obvious that children, according to age, require varying quantities of food—that is to say, different fractions of a man's ration. Likewise, women consume less food as a rule than men. Standards have therefore been fixed by which the food requirements of the women and children of a mixed population, can be reduced to man values. Of these, the standards given by Atwater are generally adopted, and are so widely known that it is unnecessary to repeat them here. They were followed, so far as the census returns allow, in determining the man value of the population of Great Britain, for the purpose of this survey, except in one particular. Atwater does not begin to give a full man's ration to boys or a full woman's ration (0·8 of a man's) until the age of seventeen is passed. In the computation here made, full rations were allocated to all above the age of fifteen. On this basis the population of Great Britain in 1908 corresponded to 30,955,000 men. But this number had to be further subdivided.

In the returns of agricultural produce, as already stated, no account is taken of farm produce consumed by the agricultural population. To meet this difficulty

[2] The ordinary calorie used for expressing the energy value of a food represents the heat required to raise a litre of water from 15° to 16° C. This proved an inconveniently small unit for expressing values of the magnitude of a nation's food supply. Accordingly a unit 1000 times as great, and called here the kilo-litre calorie, is used for the most part throughout.

[3] Eggs, margarine, lard and imitation lard are here included in this group.

The remaining quantities were distributed amongst the whole population per *man*. These are:—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)
1,690,469,028	11,339,769,322	2,147,875,965	33,334,184,454

This mode of distribution—at best an approximation, but the most accurate at present available—involved a calculation of the agricultural population, and then its reduction to man value. Various estimates of the agricultural population have been made, some of which the writer considers excessive. An independent one, made for this survey, and based mainly on the census returns, placed the number in 1908 at 5,304,691, with a man value of 4,260,000. Deducting the latter figure from the total man value of the population—30,955,000—leaves a general population of 26,695,000.

A computation on these lines gives the following ration per *man* per day, for the population of Great Britain:—

	Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
(*a*) Agricultural supplies	33·91	131·99	50·44	1,179
(*b*) General supplies ...	67·79	455·13	86·06	2,950
Total	101·70	587·12	136·50	4,129

The Daily Ration in Terms of Food.

The actual sources from which the foregoing foodstuffs and energy are derived are shown below. This list of foods and quantities may therefore be taken as the British daily ration, provided by the total supply, as given in available returns:—

TABLE II.—*The Daily Food Ration of Great Britain.*

	Quantity (oz.)	Protein (grms.)	Carbo-hydrate (grms.)	Fat (grms.)	Energy value (grms.)
Flour and meal ...	14·55	32·80	311·10	6·80	1,476
Meat...	8·17	30·91	0·10	61·34	699
Fish	2·11	4·83	—	0·83	29
Vegetables: Potatoes	15·54 / 4·74	11·44	95·22	1·15	461
Dairy products:					
Milk and cream ...	0·66 pt.				
Condensed milk ...	0.37 oz.	16·65	221·54	45·25	588
Butter	1·02 ,,				
Cheese	0·51 ,,				
Lard and margarine	0·08 ,,	0·90	—	17·18	162
Eggs (2·94 per wk.)	0·74 ,,	2·46	—	1·93	29
Sugar, ordinary ...	4·40 ,,	0·23	139·30	—	572
Glucose and treacle	0·64 ,,				
Fruit, fresh	3·85 ,,	0·60	12·17	0·29	56
Fruit, preserved and nuts ...	0·48 ,,	0·43	6·68	0·70	41
Cocoa and chocolate.	0·09 ,,	0·45	1·01	0·67	13
Olive oil	0·01 ,,	—	—	0·36	3
Total		101·70	587·12	136·50	4,129

That is to say, the daily supply of food per *man* in Great Britain as above shown consists in round numbers of $14\frac{1}{2}$ oz. of flour and meal, $8\frac{1}{6}$ oz. of some form of flesh meat, 2 oz. of fish, $15\frac{1}{2}$ oz. of potatoes, $4\frac{3}{4}$ oz. of other vegetables, two-thirds of a pint of milk, 1 oz. of butter, $\frac{1}{2}$ oz. of cheese, $\frac{1}{3}$ oz. of condensed milk, $\frac{2}{3}$ oz. of lard and margarine, less than half an egg, $3\frac{1}{5}$ oz. of fresh fruit (such as apples, pears, oranges, bananas, etc.), $\frac{1}{2}$ oz. of dried fruit, $\frac{1}{10}$ oz. of cocoa, and $\frac{1}{100}$ oz. of salad oil.

But the published returns do not include the full home supply of cheese, eggs, rabbit, meat, or poultry, and probably also of cabbage used as human food. Additions to cover these omissions bring up the daily ration of meat to $8\frac{1}{3}$ oz., of vegetables to $5\frac{1}{4}$ oz., of cheese to $\frac{5}{8}$ oz., and the supply of eggs to 3·34 per week. The food and energy value of the ration would thus be increased as follows:—

Protein (grms.)		Carbohydrate (grms.)		Fat (grms.)		Energy value (litre calories)
104·47	...	587·84	...	138·94	...	4,169

As a fair estimate, it would be safe to say that the gross values of the British daily food ration per *man* do not exceed the following, namely:—

Protein (grms.)		Carbohydrate (grms.)		Fat (grms.)		Energy value (litre calories)
105	...	590	...	140	...	4,190

The marked feature of this ration is the large quantity of fat. But a careful revision of all the sources of this foodstuff, and of the calculations upon which the total supply is based, only confirms the estimate. Moreover, the fat supply in the German daily food ration before the war, as published by the Eltzbacher Committee, is almost identical, and the ration as a whole corresponds closely with that of Great Britain. The German ration in the report of the committee is expressed in quantities per head of the population, and includes alcoholic drinks, which are left out of the present survey.

Deducting for these, and giving the quantities per *man* per day, the gross values of the ration are as follows:—

Protein (grms.)		Carbohydrate (grms.)		Fat (grms.)		Energy value (litre calories)
117·6	...	660·5	...	136·3	...	4,428

The values of the German ration are for food as produced or delivered at the port; those of the British ration, as here stated, are in the main the same. To get the values as purchased by the consumer, a deduction has to be made for loss in distribution. This is placed between 5 and 10 per cent. Taking it as 7·5 per cent., and deducting from the highest of the estimates, the values of the British ration "as purchased" are:—

Protein (grms.)		Carbohydrate (grms.)		Fat (grms.)		Energy value (litre calories)
97·13	...	545·8	...	129·5	...	3,875

On comparing the British ration with accepted standards for moderate and hard work, it is found to give an energy value between the two. Dr. Langworthy places the values "as purchased," for moderate work, at 115 grams of protein, with sufficient other food to give 3800 litre calories. Taking the mean of four standards for hard work, namely, Playfair's for English labourers, Gautier's for French labourers, Atwater's for American operatives, and Colonel Melville's for soldiers on active service, the values come out to be: protein 145 grams, with sufficient other food to give 3900 calories. The protein in these standards is considerably higher than in the British ration. But there is no disadvantage—probably the reverse—in reducing the intake of protein provided the calorie value is kept up.

Dealing with the possibility of economy in the British ration, it will be seen that the values arrived at—assuming this survey to be correct—afford no evidence of excessive supply or of waste of food. The quantity provided per man per day is just sufficient for fairly hard work. The distribution is, of course, never even; the well-to-do get somewhat more than their share, the poor less.

But the great bulk of the population—the middle classes—appear to get no more than enough to do their work, and any reduction in the total food energy would endanger the health and strength of the working man.

Where, then, is economy to come in? The answer is: (1) in substituting vegetable foods, rich in protein, such as oatmeal, peas, lentils, and beans, for part of the more costly meat supply; (2) in teaching those who have not this knowledge the great value of such foods, and how best to cook them; and (3) in the exercise of strict economy and thrift to prevent waste and make the fullest use of every article of diet. These lessons I find are admirably inculcated in a pamphlet issued by the Board of Education, entitled "Economy in Food" (Circular 917). The results of this inquiry strongly emphasise them.

A change in the directions indicated would have other useful effects also. Demand and supply reciprocally act on each other; demand creates supply, and supply influences consumption. This applies just now, more particularly, to agricultural produce. There can be no doubt, and the fact needs reiteration, that *the arable land of the United Kingdom is not used to the best advantage in the matter of food production.* The writer has elsewhere[4] pointed out that the yield of food per statute acre is far less if employed to graze cattle and sheep than if used for growing grain, potatoes, or other vegetable foods. A calculation based on average results placed the yield per statute acre in beef or mutton at 260 oz. of protein and 290,000 litre calories of energy. The same area of land furnishes, in potatoes seventeen times as much protein and thirty times as much food energy; in oats eighteen times as much protein and fourteen times as much food energy; in wheat nineteen times as much protein and fifteen times as much food energy; in beans twenty times as much protein and nine times as much food energy; in peas ten times as much protein and

[4] "Food Values." Dublin: Dollard and Co., 1915.

four times as much food energy. Even in the yield of flesh meat the advantage is on the side of tillage. More stock can be fed and more meat produced by tillage. This is particularly shown in the case of pig meat. The produce of an acre of land provides, as pork or bacon, nearly five times as much protein and seven times as much food energy as if the land were used for grazing sheep or cattle.

W. H. THOMPSON.

HARVARD CONTRIBUTIONS TO PHYSICS.

VOL. II. of "Contributions from the Jefferson Physical Laboratory of Harvard" consists of reprints of eighteen papers which have appeared in the *Physical Review* and elsewhere during the years 1913–14. The research work which these papers represents was largely aided by the Coolidge and other funds for original research. Dr. Bridgman's high-pressure work occupies a large share of the volume. We have already noticed in these columns his paper on the technique of high-pressure experimenting. From his other papers in the present volume it seems now clear that the melting points of solids continue to rise as the pressure is increased to 12,000 kilos. per sq. cm. at a rate which shows no sign of the existence of maximum melting points or of any critical points in the melting-point curves. Of the late Prof. B. O. Peirce's work on the magnetisation of short cylinders we gave an account some time ago. Prof. H. C. Hayes shows that a rate-flow meter for fluids depending on the difference of pressure at the centre and side of a vortex can be constructed to give results correct to within 1·5 per cent. Mr. J. Coulson describes an apparatus for reproducing and measuring very short intervals of time depending on the difference of time an elastic wave takes to pass from a point near the middle of a rod to the two ends. Prof. Lyman has investigated the arc and spark spectra of mercury in the region from $\lambda=1870$ to 1270, and has found that the positions of the lines do not agree with the predictions of Hughes from photo-electric data. In the theoretical field, Prof. Hall shows that the phenomena of thermo-electricity seem to be due to free electrons, but that electric conduction seems to a large extent independent of them. Prof. Webster concludes that the phenomena of radiation, of optics, and of photo-electricity can be explained, without discarding the classical dynamics, by the aid of the Parson magneton—a ring of electrons of diameter one-tenth that of a hydrogen atom moving round its axis with the speed of light. From these short notes it will be seen that the volume constitutes a record of research of which any university may be proud.

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THE ORGANISATION OF SCIENTIFIC RESEARCH.[1]

AMONGST the indirect results of this appalling war, we may hope that there will be some increased appreciation in the minds of the politicians who govern us of the enormous influence of scientific research and discovery, even in its most abstruse forms, on the prosperity and safety of the Empire. We have had brought home to us that this war is a war quite as much of chemists and engineers as of soldiers and sailors. Hence, from the point of view of national security alone, we must take steps to foster scientific investigation. We shall probably never succeed in convincing the unthoughtful multitude of the manner in which the highest scientific researches affect human life in innumerable ways, but it will be sufficient if that fact is brought home to the consciousness of those who have political position and power, and if we can impress upon them that theirs will be the responsibility if they neglect to encourage it.

Methods of Scientific Research.

The great bulk of all our scientific discovery and research in the past has been due to individual labour and initiative; much of it a labour of love, unrecognised at the time. Men of great genius have opened up new lines of thought or pursued private researches often with very inadequate appliances. In fact, the greater part of past British scientific research may be said to have been amateur work, not in the sense that

[1] Abridged from a paper read before the Royal Society of Arts on February 9, by Prof. J. A. Fleming, F.R.S.

it was lacking in the highest qualities, but only in the sense that it was pursued for the sheer pleasure and interest of it by private individuals. It was done mostly at odd times, and nearly always at the worker's own expense.

The point seems to have been reached at which the first attempt to organise research should be to create something more resembling an army out of the multitude of independent scientific workers. An army is not a collection of armed individuals, each pursuing his own aims and ideas. It is a complex organism in which each man has place and duty. No great enterprise can be carried out unless there is some degree of surrender of initiative and acceptance of directions from a higher command. To carry out this principle in scientific work we require to a fuller extent than we have it at present the system of scientific work done to order. This means that young investigators, and even the older, shall be content to take up pieces of prescribed work, quantitative or qualitative, and carry it out individually or conjointly in connection with certain large plans of operation.

This conjoint or co-operative work would have several advantages. It would save much reduplication, and it would train beginners in the best methods of research. It would effect a saving of time and enable us much more quickly to reach a given point. There is much plain and straightforward research which can be carried out when its general lines are indicated to those not possessing very great originality, but yet having perseverance, accuracy, and skill.

If, however, such work is to be undertaken by those who may perhaps be called the privates and non-commissioned officers of the scientific army, then it presupposes a directing power which shall supply what I have elsewhere called the strategy of scientific research. This must, of course, come from the more experienced and able workers, and it is to them that we must look for ideas. If some men are to surrender initiative in their work, then others must give time and thought to planning the outlines of the scientific campaigns.

We need not only the regimental officers but the General Staff if there is to be effective achievement. My contention is that this specification of the main lines of suggested research is a matter which should largely occupy our learned societies, and in particular the Royal Society, from its broad and general character and unique position.

But something more than this is necessary. We have to formulate in precise detail the suggestions for future work, and bring them to the notice of those who may be able or willing to work them out. The White Paper, which was issued last July by the Board of Education, signed by Mr. Arthur Henderson, seems intended to bring into existence some machinery for effecting this desired end. So far as the "Scheme for the Organisation and Development of Scientific and Industrial Research" outlined in this White Paper is formulated in detail, it appears to consist in the establishment of (i) a committee of the Privy Council, which will be responsible for any expenditure voted by Parliament for scientific and industrial research; and (ii) a small advisory council, composed mainly of scientific men and men actually engaged in industries dependent upon scientific research.

The primary functions of the advisory council are stated to be to advise on:—(1) Proposals for instituting specific researches; (2) proposals for developing or establishing special institutions for the study of problems affecting particular industries; (3) the establishment and award of research studentships and fellowships.

The White Paper tells us that it is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned on which it would be desirable to enlist the services of persons actually engaged in science, trades, or manufactures.

It is clearly impossible for any single board composed of a few men, however eminent, to deal in any reasonable time with all the research problems awaiting solution in physics, chemistry, inorganic, organic, and technical, metallurgy, engineering, electrotechnics, bacteriology, agriculture, etc., and the questions concerned in the recovery of our trade in dyes, drugs, glass, ceramic ware, ferro-alloys, and scientific apparatus.

Hence separate bodies of experts will unquestionably be required to deal with the different subjects in order to bring to bear upon them the proper technical knowledge and to guide research on the right lines. But now, if this is the case, the question at once arises: Why is it necessary to create a new machinery for dealing with these matters? Have we not already in the councils of our learned and technical societies, or in committees of their members, all that is required to form these boards, which might be called Permanent Advisory Committees on scientific research? Why is it considered necessary to create new committees?

The proposition I submit for your consideration is that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. The essential matter is that this organisation of scientific research should not become bureaucratic or academic, but should be conducted by bodies represenative of the best technical and scientific opinion, and be closely in touch with the members of all the various scientific and technical societies. If these permanent advisory committees in the different subjects were elected from the councils or members of the various societies, we should have in them men who are closely in touch with those particular branches of pure or applied science.

If public funds are to be administered, then it might be proper that certain of the members on each board should be appointed by the Government Department concerned, say, by the Board of Education; but my contention is that the organisation work should be the work of scientific men as a whole and not any small section of them, or be carried out by Departmental officials over their heads.

Suppose, then, we assume that we have created permanent advisory committees for the different branches of pure and applied science, the duty of which should be the organisation of research in their respective departments. Their first work should be to draw up as comprehensive a report as possible, pointing out the general needs of each department of knowledge and the most necessary directions of research in it.

The first report would no doubt have to be concerned chiefly with the deficiencies in the appliances and means of conducting it, such as laboratories and apparatus. Also with the numbers and supply of men available for undertaking it or actually engaged on it. Later reports would then be properly occupied with the more detailed discussion of the problems awaiting investigation and particular suggestions for directions of research. Each advisory board should have its salaried recorder or secretary, who should be a scientific man with some literary attainments. Each board should, of course, have taken evidence from all kinds of experts in its own subject in drawing up its report, so that this document would then be not the mere embodiment of the opinions of a few, but the concentrated wisdom of all those engaged in the same field of work. Such reports, if made annually, would come to possess immense value and form a solid basis for suggested practical reforms.

It has sometimes been suggested that the State should make pecuniary rewards for scientific discoveries or inventions, but this is not a very practicable proposal. It is extremely difficult in most cases to appraise the value of a scientific discovery or invention in its early years, and in the next place there are pieces of scientific work the real value of which does not appear until long after the death of the originator.

Who, for instance, could have set a value on Faraday's discovery of induced currents or magneto-electric induction, when in ten days of intermittent work at the Royal Institution in the autumn of 1831 he gathered in new knowledge of surpassing importance to mankind? These facts had no apparent value at the time, yet their application has brought wealth in untold millions into the exchequer of nations.

I remember speaking, shortly after Clerk Maxwell's death in 1879, with an eminent Cambridge mathematician concerning Maxwell's great paper published in 1865 "On the Dynamical Theory of the Electromagnetic Field." He told me in all seriousness that the impression produced on his mind by this great paper was that it was one of the most exalted productions of the human intellect. Yet it was twenty years, and long after Maxwell's death, before this paper brought forth its fruit in Hertz's work, and thirty-five years before we saw the final outcome of it in the achievements of wireless telegraphy.

How would it have been possible for contemporaries properly to give a value to that suggestive paper in terms of current coin? I believe the only practical method of assisting scientific research is by a well-devised system of research scholarships, fellowships, and professorships renewable annually or at longer intervals, and in any case held subject to productive work.

If we combine such a system with the above suggested advisory boards, there is a possibility of creating a workable system for the endowment and encouragement of scientific investigation which will be kept in close contact with practical necessities as well as with the most fertile regions of scientific thoughts.

Provision of the Means for Conducting Scientific Research.

One rather startling experience at the outset of this great war was the discovery of the extent to which we had become dependent on Germany and Austria for these implements of research. We found that our sources of supply of chemical glass such as flasks, beakers, tubes, graduated vessels, and more complicated pieces of analytical apparatus was cut off. Also porcelain crucibles, basins, tubes and retorts, filter papers, and large numbers of research chemicals were not produced in England of the requisite quality.

Amongst pharmaceutical chemicals a very large number have been unobtainable, or obtainable with difficulty, since the war—such as salicylates, salvarsan, veronal, and phenacetin. My colleague, Prof. Cushny, informs me that all the more complex synthetic chemicals, such as those used as indicators, stains in microscopic work, etc., have been obtained from Germany and are now unobtainable.

In physical and electrical work there has also been the same difficulty. Before the war we obtained many necessary materials from Germany which ought to have been made here. I instance such things as types of electric resistance furnaces for laboratory and assay work. Kathode ray oscillographs and the proper type of electrostatic influence machines for working them. Certain types of mechanical pumps for making high vacua. Extremely fine wires of different materials necessary for thermo-electric ammeters for high-frequency current measurements in wireless telegraphy, and also special alloy wires for electrical resistances, and many other similar materials.

We were at one time even entirely dependent on Germany and Austria for electric arc carbons, and only the enterprise of one British firm saved the situation. We are even now in difficulties as regards some electric fittings and appliances.

As an instance of the way in which the Germans look forward and anticipate the future, we may note the case of tungsten ore. When, after prolonged scientific researches, the metallic filament electric lamp made with drawn or pressed tungsten wire had ousted the carbon lamp, and when the immense importance of tungsten-steel had been recognised for high-speed tools and magnet manufacture, German interests set to work to secure the control of sources of supply of tungsten, even within the British Empire. One of the chief sources of supply of wolframite, an ore from which tungsten is obtained, is in Burma, which produces about one-fifth of the world's supply. Before the war the Germans used to secure nearly all this ore and carry out the reduction in Germany. Consequently, when the war broke out there were few or no reduction works in England capable of supplying tungsten or ferro-tungsten.

In spite of this extremely valuable tungsten supply in Burma, which is the largest mineral-producing province of India, the local government was not provided with any mining expert who could have advised them in this matter.

It is satisfactory to note, however, that steps have been taken to remedy the state of affairs. The Lieutenant-Governor, Sir Harcourt Butler, visited Tavoy, the centre of the industry, last December and addressed the Chamber of Mines. He urged the concessionnaires to do all that was possible to obtain the wolframite required at present for the making of munitions, and represented that if private owners did not meet the British demand, concessions would be cancelled and the Government would take possession. Nevertheless, the Germans have provided themselves with large stocks of this valuable material already, without which it is impossible to make modern high-efficiency incandescent electric lamps or high-speed cutting tools for engineering work. This is only one out of many instances which might be quoted to show our extraordinary want of scientific foresight in allowing absolutely essential materials to be taken by Germany both before and during the war.

This partial famine in essential scientific materials and apparatus is not due to any real want of scientific ability on the part of British inventors or manufacturers. It is due to causes which are very deep-seated. For one thing, our easy-going national temperament has found it less trouble to buy from abroad than make for ourselves. Labour difficulties, our fiscal policy, and other causes have rendered it difficult to compete with German prices.

Above all, the mistakes and ignorance of politicians who allowed themselves and others to believe that there was no real danger of a rupture of peace, and that Germany's tremendous preparations for war had no other object than defence against sudden attack by jealous neighbours, acted like an opiate on our spirit of commercial enterprise and dulled our instinct of self-preservation. Meanwhile, it is to be hoped we are now awake to facts, and that scientific men, manufacturers, and our statesmen will unite in remedying the present serious condition of affairs.

Now the question is: Are we going back, when peace returns, to the old easy-going habits of importing German-made scientific apparatus? Surely the answer is, No! a thousand times No! But unless we wish Germany's crime-stained hands to take back in commerce what she has lost in war, we have to create and maintain an entire scientific and economic independence of our own. For this purpose we need, for one thing, a properly-complete Scientific Intelligence Department.

The different agencies, committees, and institutions which have been endeavouring to supply scientific information as to manufactures should have as their resultant a single organisation, the function of which should be to collect and distribute all possible information concerning the mode of manufacture and cost of production and information concerning the patent position, if any, of all the appliances and materials used in scientific research. Such a scientific intelligence and information bureau might need subsidising at the start, but it might be possible later on to make it self-supporting by the subscriptions of firms and persons who desired information on particular matters. Just as one can pay a fee to a patent agent to conduct a search for anticipations on some particular subject, so this information bureau should have as its object to collect and supply to its subscribers all possible information concerning the manufacture or supply of the materials and implements of scientific research. This bureau might have certain laboratories or workshops attached to it where information could be tested and specifications issued for the manufacture of the materials and appliances used in research. It should not be concerned either with actual trade manufacture or with researches *per se*, but should enable anyone to find out with the least expenditure of time the exact way in which certain scientific materials or instruments are made and under what conditions they can be produced, and to supply this information to the trades concerned who are its supporters or subscribers.

Training of Men to Conduct Scientific and Industrial Research.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can scarcely be doubted that much can be done to foster and assist it.

The nation must be educated to see that the men with high scientific and inventive ability in it, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality. In spite of all that has been written and said on this subject, we do not seem to be nearer to essential reforms. The object of all education is threefold: first to train character, will, and that power of selecting the best amongst various courses of action which we call right judgment; secondly, to impart necessary information and ability to do certain things well; thirdly, to develop initiative and the power of handling new problems or investigations and a certain alertness in dealing with new situations. Our present methods of education are far too much directed to supplying ready-made and peptonised information.

The great outstanding fact in modern life is the degree to which the energies and materials of Nature are employed to overcome the difficulties created by the increase and concentration of population. We have to make the earth bring forth her increase at a greater rate, to supply the ever-increasing necessities of growing populations and the many artificial wants which have been created by progressive human desires. Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind. Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it. In our public schools we train boys chiefly by directing their attention to words in the form of the grammar and literature of two dead languages, and we neglect to give them any wide and sufficient knowledge of things—viz., the physical phenomena of the universe in which they live.

Is it, then, any wonder that when these boys grow up and take their places in Government offices, in the Law Courts or on the Press, or any other influential position, they are oblivious to the last degree of events taking place in the world of science which have in them the power to make or destroy national industries or affect the living of large populations? The destruction of the madder industry of France and the indigo industry of India by German synthetic chemistry are now old and familiar stories.

The point, however, to notice is that the scientific chemical discoveries were not allowed to remain mere laboratory feats. They were transformed into successful commercial enterprises. The Badische Anilin- und Soda-Fabrik is said to have expended 1,000,000*l.* and taken seventeen years' work in translating Baeyer's scientific synthesis of indigo into a factory process. But the result has justified the foresight of those who expended it. This is only one instance out of many which could be quoted to show the blows that can be inflicted in this industrial warfare, the weapons in which are not shot and shell, but scientific discoveries and inventions.

The supremely important question is: What are the steps we are taking to train the men who will enable us to hold our own in this commercial conflict? It avails nothing to point out that the beginnings of many of these achievements were laid by British scientific discoveries or original suggestions. A truth or a suggestion which is not followed out or pressed to the point at which it becomes practically productive is like a seed which is not planted in the ground. The intellectual perception of a truth or principle requires behind it the driving force of character and will if it is to pass into the useful stage.

Some people might be inclined to ask why there should be this competition and pressure to invent? What difference does it make who discovers a new fact or makes a new application? If scientific knowledge were a mere matter of intellectual curiosity concerning the secrets of Nature it would not matter much, except for national honour, who made the discoveries or applications. But scientific knowledge has become much more than this. It has become the means of increasing national wealth, and also by which national wealth can be taken away. Again, in virtue of our patent laws, it has become possible for alien inventors to prevent us from even using in our own country in particular ways the waste products of our own industries, as in the case of certain coal-tar products. Hence scientific knowledge can be applied so as to become a tremendous weapon of destruction as well as of national strength. It is for this reason that we require men to be trained, not merely to make scientific discoveries, but to make useful commercial applications of them, which are wealth-producing or wealth-conserving in a national sense. This requires a peculiar combination of scientific ability and commercial insight, and it is just here that Germany has the advantage.

Mr. Lloyd George said on one occasion that he feared Germany's war-bread spirit, by which he meant the willing subjection of a whole Empire to discipline. We might say, with even more truth, that what is to be feared is Germany's militant chemistry and engineering, or that combination of commercialised science which is relentlessly applied to undermine and take away sources of power of other nations. This, however, is what we have to meet. We have to train chemists, engineers, electricians, and physicists who are not only learned in the knowledge of their science and originative in discovering new facts and principles, but have also a keen commercial sense which directs them to the solution of the practically useful problems. We have, therefore, to create a very much closer union between industry and science. To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of man more useful in the factory. For this reason I am an advocate of the so-called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches, but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student-apprentice, so as to turn out all-round men and not unpractical theorists or unscientific practists. We have to improve in many ways our college teaching, so as to expend to better advantage the available time and place more stress on ability to use information than to store it. Engineering and chemical students should be brought much earlier than at present into contact with questions of cost and estimates, so that they may know not only how and why a certain machine works, but what it costs to make it, or to run it. They will then be far better able to take advantage of the workshop training and obtain earlier that "workshop sense" or instinct which looks at everything from the point of view of cost and profit, as well as operation or efficiency.

We have before us a tremendous task to restore the waste of this great war. To do this we have to utilise all waste products and to abolish waste and inefficiency in all departments of life, domestic, commercial, political, and industrial, and we have to get rid of them in scientific work as well. We can only do this by bringing to bear the scientific method upon all these regions of activity and even upon scientific research itself. As a small contribution to this work the above suggestions are tentatively put forward, and with the greatest diffidence I submit them now to your careful consideration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A friend of the late Dr. Donaldson, master of Magdalen College, has endowed a bye-fellowship of the annual value of 100*l*., to be called the Donaldson Bye-Fellowship, in memory of the late master; the fellowship is intended for the encouragement of research, and is tenable for one year. The Financial Board reports that Sir Eustace Gurney has offered to present to the University a farming estate of about 257 acres with a view to the encouragement of the study of forestry in the University; the net income in rent of the estate is about 10*l*. per annum. The General Board of Studies reports that the council of the Royal Geographical Society has decided to make grants of 300*l*. per annum for five years to the schools of geography in Oxford and Cambridge. Mr. H. H. Brindley, of St. John's College, has been appointed demonstrator of biology to medical students, and Mr. C. Warburton, of Christ's College, demonstrator in medical entomology; both appointments are for a period of five years.

LONDON.—The following new doctorates in science are recorded in the *London University Gazette* for February 9:—*Physics*: E. J. Evans (Imperial College—Royal College of Science), for a thesis consisting of three papers on spectroscopy published in (i) NATURE, September 4, 1913; (ii) *Phil. Mag.*, February, 1915; (iii) *Phil. Mag.*, January 1916. *Organic Chemistry*: Biman Bihari Dey (Imperial College—Royal College of Science), for a thesis entitled "A Study in the Coumarin Condensation" (Trans. Chem. Soc., 1915). *Applied Statistics*: Leon Isserlis (University College), for a thesis consisting of the following papers:—(i) "On the Multiple Correlation Ratio," parts i. and ii. (*Biometrika*, November, 1914, and November, 1915); (ii) "On the Conditions under which the 'Probable Errors' of Frequency Distributions have a Real Significance" (Proc. Roy. Soc., A., 92, 1915).

A NOTE in the *Times* of February 10 states that Mr. C. E. Probyn, who died on December 1 last, left estate of the gross value of 14,563*l*., the residue of which, amounting to about 10,000*l*., is bequeathed to the University of Bristol.

WE gather from the *Münchener medizinische Wochenschrift* that of the 18,110 students inscribed during the present semester in seven of the German universities, 13,629 are absent in the army, *i.e.* slightly above 75 per cent.

DR. E. H. GRIFFITHS, principal of the University College of South Wales and Monmouthshire, who had arranged to resign at the end of the present session, has consented, at the request of the council, to continue in office until the end of the session 1917–18.

WE learn from the *Pioneer Mail* that the staff has now been selected for the Lady Hardinge Medical College and Hospital at Delhi, which Lord Hardinge opens to-day:—Principal and professor of medicine, Dr. K. A. Platt; professor of anatomy and gynæcology, Miss Hitton; professor of pathology, Miss Field; professor of anatomy, Miss Murphy; professor of chemistry, Miss A. M. Bane; professor of biology and physiology, Miss M. R. Holmer. It is expected that tuition will begin next September, and the Government of India will contribute a lakh of rupees (6700*l*.) yearly to the annual maintenance charges.

THE issue of the *Pall Mall Gazette* for February 8 contained an interesting account of an interview with Sir Philip Magnus, in which he expressed his views on the changes desirable in the education of this country. Larger grants for scientific industrial research, though imperatively necessary, will not be enough. What our system of education should be after the war must be inquired into. Our children will have to be taught their duties as citizens of a great Empire, and in relation to our Dominions overseas. Sir Philip Magnus advocated the appointment of an independent and competent committee, such as was suggested by him in the House of Commons on January 26 (see NATURE, February 3, 639), to inquire into the whole question. Scientific education must be made more general and the spirit of our people be made scientific. Science must be given full play in all our activities, and especially must it govern our organisation. Such a committee would be able to effect concentration, and its recommendations should lead to reforms and development of the Board of Education. While it is of the utmost importance that we shall apply science to commerce, to industry, and to other purposes, it is, said Sir Philip, still more important to keep steadily in mind that the highest aim of education is so to develop the character of our people that they shall act as moral human beings.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 10.—Sir J. J. Thomson, president, in the chair.—Lord **Rayleigh**: The theory of the Helmholtz resonator. The ideal form of a Helmholtz resonator is a cavernous space enclosed in a thin immovable wall, but communicating with the external atmosphere by means of a small perforation. An approximate theory is due to Helmholtz, who arrived at definite results for apertures the outline of which is circular or elliptic. In the present paper the approximation is carried further for the special case where the wall is spherical, with the aid of the appropriate Legendre's functions.—Sir Norman **Lockyer** and H. E. **Goodson**: The oxyhydrogen flame spectrum of iron. A spectrogram of the light emitted when metallic iron burns in the oxyhydrogen flame, notably rich in lines due to the metal, has been studied. Sixty-four lines of iron have been identified in the region $\lambda\lambda 3856{\cdot}52-5615{\cdot}88$. Fifteen of these lines do not appear to have been hitherto recorded in the iron-flame spectrum, and a number of these latter possess special interest. On the basis of a comparison of the flame spectrogram with a spectrum of the iron arc of approximately similar exposure, it has been possible to separate the flame lines according to the observed variations of intensity into two well-marked groups, whilst a residuum forms an intermediate group. All the flame lines have accordingly been placed in one or other of the following three groups :—

Group A containing lines stronger in flame than arc.
,, B ,, ,, weaker ,, ,,
,, C ,, ,, nearly equal in both sources.

This division bears close relation to the more minute classification employed by King in the case of spectra obtained at varied temperature levels in the electric furnace.—W. G. **Duffield** and M. D. **Waller**: The consumption of carbon in the electric arc. III.—The anode loss. It has already been shown that the rate of consumption of carbon from the kathode of a very short arc is such that the departure of one atom is accompanied by the transfer between the poles of four electronic charges. The above experiment gave a clue to the *rôle* played by the kathode. Experiments were undertaken to determine the part played by the anode. It appears that the anode loss of carbon is unimportant in the mechanism of the arc, and that the function of the anode is to receive the carriers of the current produced by the essential process occurring at the surface of the kathode. The formation of a crater in the normal type is not vital to the arc, though it is its most prominent feature. The reduction in potential difference in the arc with rotating anode is probably due to absence of electronic emission on a large scale from its cooler anodes.—C. H. **Lander**: Surface friction : experiments with steam and water in pipes. The work comprises a verification of Rayleigh's formula connecting resistance with velocity, density, diameter of pipe, and kinematical viscosity of fluid. The results are slightly above those obtained by Stanton and Pannell for water and air in brass pipes, and show similar characteristics. The general results of the work confirm the accuracy of the assumptions made in the derivation of the equation

$$R=\rho v^2 F\left(\frac{vd}{\nu}\right)$$

for fluids differing as widely in their properties of viscosity, density, etc., as steam and water.—T. R. **Merton**: The structure of broadened spectrum lines. It is considered improbable that the broadening of spectrum lines which occurs at high pressures and under conditions of powerful electric discharge can be referred to the movement of the atom as a whole, but rather to processes more intimately connected with the problem of radiation. Stark has suggested that the broadening is closely related to the electric resolution of the lines. On this assumption the distribution of intensity to be expected in the lines $H\alpha$, $H\beta$, and $H\gamma$ of hydrogen, broadened by powerful discharges, is discussed. A method of investigating the distribution of intensity in these broadened lines has been found. This method is not affected by the eccentricities of the photographic plate and is adapted to quantitative measurements. The results for the hydrogen lines show that $H\alpha$ consists of a strong maximum falling off rapidly and regularly on either side, $H\beta$ falls off much less rapidly and shows a minimum at the centre of the line, and $H\gamma$ shows a strong central maximum with very diffuse "wings" on either side.

PARIS.

Academy of Sciences, January 24.—M. Camille Jordan in the chair.—L. **Maquenne**: The comparison of the action of saccharose and of invert-sugar on alkaline copper solutions. Supplementing an earlier note on the same subject, details are given of the influence of temperature and time on the reduction by invert sugar and by cane-sugar.—Boris **Delaunay**: The general solution of the equation $X^3\rho+Y^3=1$.—Gaston **Julia**: Positive quadratic binary forms.—Maurice **Fréchet**: The deviation of any two functions.—A. **Liljeström**: The difference between the centre of gravity and centre of inertia.—G. **Mouret**: The flow of liquids over a thin edge.—Ernest **Esclangon**: The trajectories of projectiles in air.—J. **Dejust**: The determination of the rational surface of the blades of a hydraulic turbine.—M. **Mesnager**: The problem of the fixed thin rectangular plate.—Thadée **Peczalski**: The mechanical equivalent of the light of an incandescent lamp.—Stanislas **Meunier**: New observations on the structure of the meteoric irons of the Diablo Canyon (Arizona): consequences relating to the circumstances of the fall of these meteorites. The author's interpretation of the structure of the meteorite agrees with the view put forward by Barringer and Tilghmann, that the crater of Coon Butte was excavated by the shock of the meteorite (see NATURE, January 27, p. 595).—M. **Dalloni**: The Senonian of Oran (Algeria).—M. **Marage**: The measurement of the sharpness of hearing in real and simulated deafness. A discussion of the importance of quantitative measurements of deafness in connection with the army.—P. **Bazy**: Delayed tetanus. The immunity given by the antitetanus serum lasts only fifteen days, and under certain conditions tetanus may develop as long as fifty days after infection. Injections every eight days for a month are suggested as a safeguard.—A. **Policard**, B. **Desplas**, and A. **Phélip**: Biological researches on wounds received in battle. The microbial flora and its relations with the clinical evolution and the characters of the wound.

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The British Journal Photographic Almanac, 1916. Pp. 984. (London: H. Greenwood and Co., Ltd.) 1*s*. net.

Transactions of the Geological Society of Glasgow. Vol. xv., part 3. Pp. 297–437. (Glasgow: Geological Society.) 7*s*. 6*d*.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College. September–November, 1915. Edited by R. M. Milne. Pp. 30. (London: Macmillan and Co., Ltd.) 1*s*. net.

Wisconsin Geological and Natural History Survey. Bulletin xlii. Educational Series, No. 5: The Geography of the Fox–Winnebago Valley. By Prof. R. H. Whitbeck. Pp. 105. (Madison, Wis.)

A Bird Calendar for Northern India. By D. Dewar. Pp. 211. (London: W. Thacker and Co.) 6*s*.

Forerunners and Rivals of Christianity, being Studies in Religious History from 330 B.C. to 330 A.D. By F. Legge. 2 vols. Vol. i., pp. lxiii+202. Vol. ii., pp. ix+425. (Cambridge: At the University Press.) 2 vols., 25*s*. net.

Commerce and Industry. By Prof. J. R. Smith. Pp. viii+596. (New York: H. Holt and Co.) 1.40 dollars.

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series. Vol. vi. Memoir No. 1. Supplementary Memoir on New Ordovician and Silurian Fossils from the Northern Shan States. By Dr. F. R. C. Reed. Pp. vii+100+xii plates. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.) 4*s*.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 17.

ROYAL SOCIETY, at 4.30.—The Action of Cobra Venom: Prof. A. R. Cushny and S. Yagi.—Gametogenesis and Sex Determination in the Gall-fly, *Neuroterus lenticularis*. III.: Dr. L. Doncaster.—The Structure and Development of the Skull and Laryngeal Cartilages of Perameles, with Notes on the Cranial Nerves: Philippa C. Esdaile.—Physiological Investigations with Petiole-Pulvinus Preparation of Mimosa Pudica: J. C. Bose and S. C. Das.

ROYAL INSTITUTION, at 3.—Variable Stars: Sir F. W. Dyson.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—A Synthetic Method of Determining Geographical Regions: Dr. J. F. Unstead.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Kelvin Lecture: Terrestrial Magnetism: Dr. C. Chree.

ROYAL SOCIETY OF ARTS, at 4.30.—The Saints of Pandharpur: C. A. Kincaid, C.V.O.

LINNEAN SOCIETY, at 5.—John Bartram; the Pioneer American Botanist: Miss C. Herring-Browne.—Acorn Producing Twin Plants: Miss M. Rathbone.—Winter and Summer Coloration of the Ermine, *Putorius ermineus*: E. S. Goodrich.—The Infestation of Bamboos in Tidal Waters by *Balanus amphitrite* and *Teredo navalis* in Tenasserim: E. P. Stebbing.

FRIDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 5.30. Polarised Light and its Application to Engineering: Prof. E. G. Coker.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting. —Chisels: H. Fowler.

MONDAY, FEBRUARY 21.

ROYAL SOCIETY OF ARTS, at 4.30.—National and Historic Buildings in the War Zone; their Beauty and their Ruin: Rev. G. H. West.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Valley of Mexico: A. P. Maudslay.

TUESDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—Nerve Tone and Posture: Prof. C. S. Sherrington.

ZOOLOGICAL SOCIETY, at 5.30.—Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Society's Gardens. I.: B. F. Cummings.—Further Observations on the Intestinal Tract of Mammals: Dr. F. Chalmers Mitchell.

ILLUMINATING ENGINEERING SOCIETY, at 8.—*Discussion*: Some Future Possibilities in the Design of Instruments for Measuring Illumination (with Special Reference to Photometers Depending on Physical and Chemical Methods).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Main Drainage of Cairo: C. C. James.

WEDNESDAY, FEBRUARY 23.

ROYAL SOCIETY OF ARTS, at 4.30.—Serbia as seen by a Red Cross Worker: Miss H. B. Hanson.

GEOLOGICAL SOCIETY, at 5.30.—The Origin of some River-Gorges in Cornwall and Devon: H. Dewey.

THURSDAY, FEBRUARY 24.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Mathematical Contributions to the Theory of Evolution. XIX. Second Supplement to a Memoir on Skew Variation: Karl Pearson.—The Relative Combining Volumes of Hydrogen and Oxygen: F. P. Burt and E. C. Edgar.—Speed Effect and Recovery in Slow-speed Alternating Stress Tests: W. Mason.

ROYAL INSTITUTION, at 3.—The Milky Way and Magellanic Clouds: Sir F. W. Dyson.

CHILD STUDY SOCIETY, at 6.—Psychological Problems arising out of the War: C. Burt.

FRIDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 5.30.—The Commerce of Thought: Sir A. Quiller Couch.

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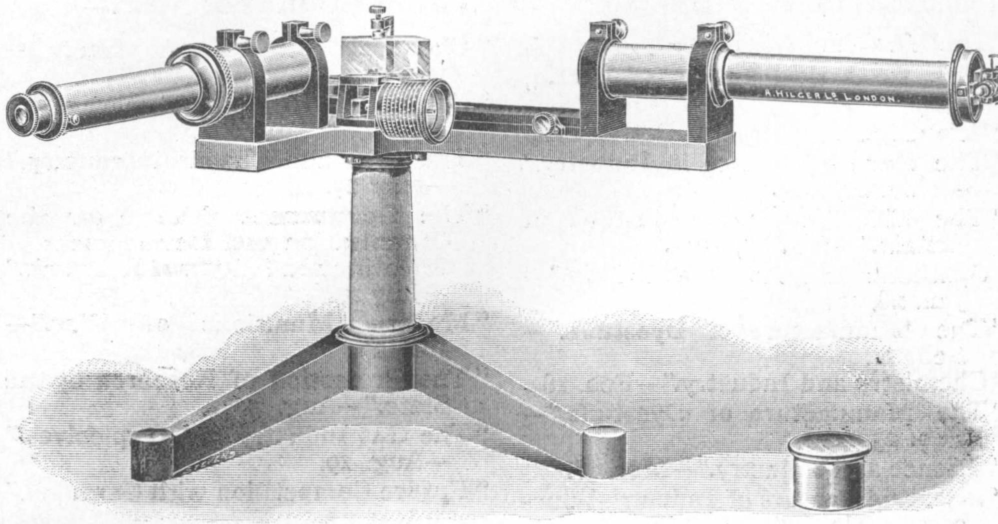

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"The Manufacture of Dyestuffs in Britain."—Jan. 21, 1915.

"Synthetic Drugs in Great Britain."—Jan. 28, 1915.

"The Manufacture of Dyestuffs."—Feb. 11.

"Chemistry and Industry."—Feb. 18.

"The Manufacture of Dyestuffs."—Feb. 25.

"Science and Industry."—Mar. 18.

"Scientific Factors of Industrial Success."—Mar. 25.

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"The War and British Chemical Industry."—April 1.

"The Position of the Organic Chemical Industry."—April 1.

"British Supply of Drugs and Fine Chemicals."—April 15.

"The Supply of Optical Glass."—May 6.

"Science and the State."—May 20.

"An Advisory Council on Industrial Research." May 20.

"Germany and the Munitions of War."—June 3.

"Poisonous Gases and their Antidotes."—June 10.

"The Mobilisation of Science."—June 17.

"Aiming with the Rifle."—June 24.

"Problems of Airship Design and Construction."—July 1.

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"The 'Wheat Problem' and Synthetic Nitrates."—Dec. 23.

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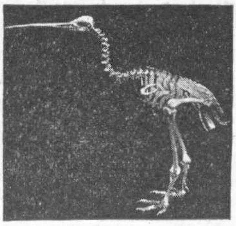

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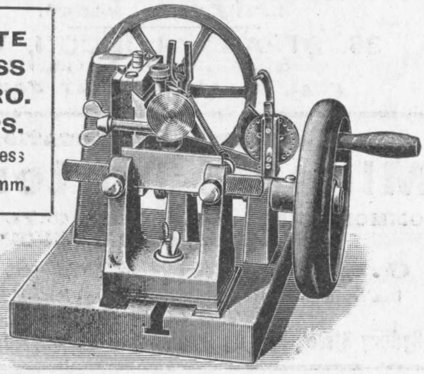

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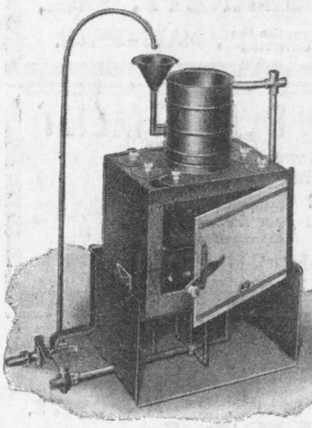

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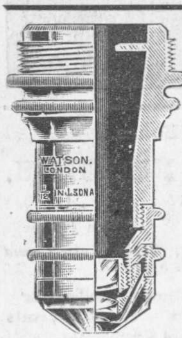

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