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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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CHEMISTRY OF PETROLEUM.

The Chemistry of Petroleum and its Substitutes. By Dr. C. K. Tinkler and Dr. F. Challenger. Pp. xvi+352. (London: Crosby Lockwood and Son, 1915.) Price 10*s.* 6*d.* net.

A BOOK on the chemistry of petroleum, written for English students, arouses a special interest if only by the fact that, although it is largely used, the raw material is neither found nor refined in this country. In short, the industry, except as a matter of buying and selling, does not exist.

The title is, however, unintentionally misleading. Although it is called a practical handbook, the term does not imply any technical details of production, such as one finds in the volumes of Sir Boverton Redwood. It is concerned only with the chemistry of the subject—that is to say, its theoretical side—and such simple practical experiments and tests as can be performed in a laboratory. Moreover, "the substitutes" monopolise a large share of the volume. For example, the descriptive portion of the petroleum industry occupies less than one-twentieth of the total number of pages, and about the same amount of space is accorded to the distillation of bituminous shale, of coal, and of coal-tar, and to the production of ethyl alcohol and wood spirit, whilst tests of various kinds, including the determination of physical constants and a few simple organic preparations, fill up the rest of the volume.

The book is actually a treatise on the chemistry and valuation of liquid fuels, and is intended to serve as a text-book for a part of the curriculum which, together with the course on petroleum mining, forms one of the subjects for the diploma or B.Sc. degree of the University of Birmingham.

Having briefly indicated the scope and object of the book, we can only express our full agreement with the writer of the introduction (Sir B. Redwood) that, in providing a text-book for students who desire to become proficient in the chemical technology of petroleum, the authors properly consider that no man can become a successful technologist until he has fully mastered the underlying scientific principles of the subject.

There is no doubt that, at the present time, when such large quantities of liquid fuel are used for motive power and where so much ignorance of the methods of estimating the value of these substances prevails, a book of this character, the aim of which is to teach technical methods of analysis, ought to, and no doubt will, command general interest. If we have one criticism to offer it is that an attempt has been made to combine the study of organic chemistry with that of technology. The whole range of organic chemistry is run through in the first 62 pages, followed at intervals by the description of a few substances which the student is supposed to prepare in the laboratory.

As a preparation for the future expert technologist in so complex and so important a branch as the chemistry of liquid fuel, we should consider this wholly inadequate, and that a substantial course of theoretical and practical organic chemistry ought to precede its applications. Apart from this, we can cordially commend the volume and the excellence of the information it contains.

J. B. C.

SIGNIFICANCE OF SEXUAL REPRODUCTION IN PLANTS.

The Evolution of Sex in Plants. By J. M. Coulter. Pp. ix+140. (Chicago: University of Chicago Press; London: At the Cambridge University Press, 1914.) Price 4*s.* net.

PROF. COULTER gives a luminous sketch of the probable history of sexual reproduction in plants. He deals with the origin of pairing gametes from spores, with the differentiation of (1) eggs and sperms, (2) specialised sex organs, and (3) sexual individuals (such as the male and female gametophytes of *Equisetum*), and with the special problems of alternation of generations and parthenogenesis. In the case of plants it is plain that the function of sex is not to secure reproduction, but to secure something in connection with reproduction which is not attained by the asexual methods. The sexual method is added on to the older asexual methods, and does not replace them. Before sexual reproduction was established there were three stages:—The primal capacity for cell-division led on to spore-formation by vegetative cells, and that to spore-formation by special cells.

The origin of sex was marked by the appearance of minute, motile gametes—reproductive cells that pair and fuse. If the material of a protoplast is divided only a few times there is spore-formation; if the divisions are more numerous the cells produced are probably gametes. Perhaps the ageing of cells stimulates the numerous divisions and the production of cells incapable of functioning as spores. Whether the pairing gametes appear similar (isogamy) or dissimilar (heterogamy) there is certainly physiological unlikeness. They are the bearers of sex-determiners and corresponding sex-inhibitors, which are passed on through generations of vegetative cells until conditions favour their expression in

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gamete-formation again. It is a mistake to suppose that nutrition determines sexuality, but it sometimes determines the opportunity for the expression of sexuality. Similarly, the nutritive supply is not necessarily related to differentiation of sex or size. The male gametophyte of Equisetum is small because it is a male, and not male because it is small.

The general theory suggested in this interesting essay is that decline of vegetative vigour favours the production of gametes with characteristic chemical substances. The zygotes that result from the pairing of gametes tend to lie dormant until environmental conditions improve—a useful and probably primary protective adaptation. The peculiarity of gametes is not to be found in their motility, or in their minuteness, or even in pairing (as is shown by nuclear fusions in endosperm-formation); what, then, is their essential feature? In the reduction division their nuclei become peculiar, so that a new individual can only be produced after the nuclei have fused. And the advantage of this is probably in securing individuality or variation. Thus sexual reproduction makes, on the one hand, for protection, and, on the other, for variability.

CASE-HARDENING.

(1) *La Cémentation de L'Acier.* By Prof. F. Giolitti. Traduction française revue par M. A. Portevin. Pp. 548. (Paris: A. Hermann et Fils, 1914.) Price 16 francs.

(2) *The Case-hardening of Steel.* By H. Brearley. Pp. xv+164. (London: Iliffe and Sons, Ltd., 1914.) Price 7*s.* 6*d.*

(1) PROF. GIOLITTI is probably the greatest living authority on the cementation of steel, and in the above-mentioned publication will be found by far the most comprehensive and lucid presentation of this subject that has ever appeared. During recent years many important original researches in this domain have been published by him and his co-workers at Turin, and no one is better qualified than he to summarise present-day knowledge with regard to it. M. Portevin, in rendering as he has done an admirable French translation of the Italian text, has considerably enlarged the circle of students to whom the book will be available.

As Prof. Giolitti remarks in his preface, there is probably no branch of present-day steel technology in which empiricism is so supreme as cementation or case-hardening. Such a condition of things, justifiable no doubt at one time, can no longer be defended. Scientific knowledge is now available which permits this highly important process to be carried out under simple and easily controlled conditions with inexpensive materials, in such a way as to secure definite results with remarkable certitude. In spite of this, many works are content to go on buying at fancy prices mixtures of a very ordinary character, the nature of which is entirely disguised by the trade names under which they are sold.

Part i. of the book deals with cementation processes from a chemical point of view, and consists of five chapters, which trace the sequence of researches that laid the foundation of scientific case-hardening, and gradually lead up to the final chapter on present-day knowledge of the subject. The author has been exceedingly careful in mastering and summarising the literature available, and in spite of his own large share of the experimental field he seems to have missed little or nothing that anybody else has done. It seems now to be well established that while pure carbon can and does under suitable conditions of heating carburise solid iron in the complete absence of any gas, yet such carburisation proceeds so slowly as to be useless from the technical point of view. All industrial case-hardening processes require the presence of gas, and to the question "What are the respective parts played by the carbon and the gas in such processes?" it is impossible to return an answer that will hold for all cases. It is necessary to examine for every type of cementing material the specific action of the gas which may be formed, and then to study how this action is modified by the presence either of free carbon pre-existing in the cement or of carbon formed during cementation.

Part ii. deals with the technical applications of cementation, and of particular interest are the chapters relating to liquid and gaseous cementing agents. It is unfortunate that the table of contents is very meagre, and that the book is without an index. It is to be hoped that the latter defect will be remedied when a second edition appears, for it detracts considerably from the usefulness of the book in its present form.

(2) Mr. Brearley's book has been written mainly for those who are engaged in the commercial production of case-hardened objects. Nothing could indicate its point of view better than the following quotation from his preface: "An explanation based on the mechanical structure of an object is intelligible, because most minds can appreciate the elements of design and pass judgment on the composite properties of materials. All kinds of steel have a mechanical structure which, when suitably magnified, is as obvious as that of reinforced concrete. It is in terms of such structures that the properties of case-hardened steels

must be explained." Chapters i.-vii. are concerned with various aspects of case-hardening processes, and these are followed by others dealing with methods of testing, automobile steels, hardening and tempering, and finally surface hardening without cementation. No attempt is made to separate the subject into practical and theoretical divisions, and the author's treatment presupposes an elementary knowledge of metallography on the part of his readers.

In a book of this kind it is gratifying to find the following opinion (p. 77): "The most helpful of all generalisations in metallurgy is the one based on observations made with the pyrometer and confirmed by the microscope, known as the equilibrium diagram." Mr. Brearley is to be congratulated on the production of a book that was well worth writing, and one which should certainly be of use to those for whom it is intended. It will repay studying, moreover, by others than case-hardeners.

H. C. H. CARPENTER.

OUR BOOKSHELF.

The Principles of Fruit-Growing. By L. H. Bailey. Twentieth Edition. Pp. xiv+432. (New York: The Macmillan Co., London: Macmillan and Co., Ltd., 1915.) Price 7*s.* 6*d.* net.

THIS book has in its different editions been used for nearly eighteen years as a standard text-book on commercial fruit-growing, in the Agricultural and Horticultural Colleges of the U.S.A., Canada, and England.

For the present edition the work has been largely re-written; it deals with important subjects, such as the choice of locality and site; the setting out of orchards; the principles of vegetable physiology involved in the cultivation, pruning and thinning of the fruit, and so on. The question of manuring of orchards, based on experiments at the American Experiment Stations, gives clear general reasons for the effect or non-effect of the fertiliser. The phenomenon of self-sterility of varieties and the advantage of cross-pollination are discussed. Examples of score cards dealing with the growth and character of the tree as well as the fruit show that this is a valuable method for comparison of varieties; an example of a work sheet of an orchard, together with cost and return, show what may be advantageously learnt from keeping such a record. Cover crops and protection from frost by orchard heating are described; control of insect pests and fungoid diseases, and the choice of pumps and nozzles, are well treated; harvesting, packing, and fruit storage houses, also special points of interest such as the origin of varieties, are discussed.

The book is one to interest any English apple grower (it is the apple that is chiefly dealt with); it presents new aspects of things different from those we are accustomed to see in current English fruit-growing literature.

The application of principles may need slight modification in this country as the work is in the first case written for North America; the main general principles, however, hold good the world over.

CECIL H. HOOPER.

Infant Mortality. By Dr. H. T. Ashby. Pp. x+229. (Cambridge: At the University Press, 1915.) Price 10*s.* 6*d.* net.

THE appearance of Dr. Ashby's book is very well timed, for in these days of human wastage it behoves a nation to conserve its resources. It is true that in recent years there has been a slight drop in infant mortality, but it is still disgracefully high, and is largely counterbalanced by a fall in the birth-rate. The word disgraceful is the correct one, because the vast majority of deaths are due to preventable causes, of which the most important is diarrhœa due to bad feeding and especially to bad and infected milk. Dr. Ashby shows that much may be done by the proper instruction of the mothers, but by far the greatest responsibility falls on public bodies and the Government, for it is only they who can deal with the larger questions of hygienic precautions, such as regulations of cleanliness in food depots, and the prevention of fly-borne disease; the call for proper regulation of the milk traffic is an urgent one; the provision of shells is important, but the provision of a healthy race to make and use them is even more pressing. We trust that useful books such as the one under consideration may bear fruit in the proper quarters.

W. D. H.

St. Bartholomew's Hospital in Peace and War. The Rede Lecture, 1915. By Dr. Norman Moore. Pp. 56 (Cambridge: At the University Press, 1915.) Price 2*s.* net.

WE welcome the publication of this Rede lecture delivered on May 6, 1915, in the Senate House, Cambridge, by Dr. Norman Moore. Such a charmingly written history of a great hospital will appeal to a wide circle of readers. As Dr. Moore says, the history shows "how in a free country such as ours, where everything is not dominated by Government, an ancient institution like St. Bartholomew's Hospital, whether in peace or war, lives with the nation and is in touch with the national life in every period."

Educative Geography. A Note-book for Teachers. By J. L. Haddon. Pp. 76 (London: G. W. Bacon and Co., Ltd., 1915.) Price 1*s.* net.

IT is to be hoped that this little book may secure a wide circulation among teachers of geography in elementary schools and the junior classes of secondary schools. It should convince all who read it that lessons in geography become both more valuable and interesting when they include simple practical exercises to be worked by the children themselves, and that the provision of such work is neither expensive nor unduly troublesome.

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 Mobilisation of Science.

THE article in NATURE of June 17 expresses forcibly what many men of science are thinking. The strange part of the matter is that the Government and the country generally do not share in these thoughts and do not take action by insisting on scientific men taking on themselves their share of the common burden. The general disregard of science is, of course, the fault of scientific men, and particularly of the Royal Society, but limitations of space do not permit me to enter upon that fascinating theme here and now. The point to be dealt with is: What is to be done now? NATURE says, on p. 419, that what is required is "the appointment of a National Committee with a free hand and ample funds for experimental work"; and that "we should possess a scientific corps, with men investigating at the Front as well as at home, instead of one or two committees advising officials as to possible means of offence or defence."

Mr. H. G. Wells, in his letters to the *Times*, seems to show that he holds the same views. Now, with all due respect to NATURE and to Mr. Wells, those methods are not in accord with our national characteristics, and are not suited to the needs of the moment. To be plain, they are counsels of perfection with the practical defects usually associated with such counsels.

Progress in our country, if not throughout the world, comes mainly, not from scientific discovery, but from its application. It is beside the mark to point out that without the researches of scientific men, the results could not be applied in practice. The advance of science is a blindfold march. No man knows whither it will lead, or what landmark may be reached even by the next step. This is not to say that each step is not carefully considered beforehand and its probable landing-place made the subject of the most earnest and profound thought. But it is to say that each step is only the preliminary to another step, and that science cares little about landmarks. The good scientific investigator is not concerned as to the immediate value of his work. He is in pursuit of truth. Let the world benefit by the way he has opened out if it is sufficiently wise. The imprisoned splendour has blazed forth. Let others work by its light.

This is precisely what the inventor does. He is not greatly interested in the splendour, but he is very much interested if he can see his way to making use of it in something "practical." He is often not particularly scientific, or at any rate has little scientific reputation. Yet a man who can apply science is in his way as useful to science as science is to him. Just now it is the applications of science we want, not the underlying science itself. We want to stimulate invention, to get hold of the men with a "practical" turn, and induce them to do their best. How is it to be done?

To find the answer, the question must be considered a little further. The main thing with an inventor—the applier of science—is to know for certain of some competent person who will listen to what he has to say, who can judge of the value of what is said, and will not rob him of his ideas. The inventor wants the credit for his own work, and if he often positively prefers something more tangible, he may perhaps be forgiven in a world where success is nearly always measured in one way. But does an inventor like to approach the Government? Of course, the man with superb self-confidence will do the most unlikely things. I will content myself with saying that many inventors would not do so. At this juncture some men at least are convinced, rightly or wrongly, that they would not receive a patient and intelligent hearing. It is impossible for the average Briton to get into his head that an official can be anything but stupid, incapable, and lazy, with a rooted objection to new ideas, especially if, as is probable, he does not fully understand them.

The method for the Government to adopt is to let it be known that the hearing will be patient and intelligent, and the adoption of new ideas immediate, if they are to be adopted at all. It is useless to set up Advisory Committees if they do not command the confidence of the men who have the knack of applying science. Possibly—I say it with bated breath—even the council of the Royal Society might not be the best Advisory Committee. Perhaps an admixture of more mundane material, even men from works who live by applying science, might be to the good. But at least it must be made clear to all by the widest publicity that the Committee is not one of officials, whose attainments are chiefly in directions other than science.

To me it seems that the various scientific and technical societies are enough, that any electrician would trust the council of the Institution of Electrical Engineers, that any chemist would trust the councils of the Chemical Society and the Society of Chemical Industry, that any metallurgist would trust the councils of the Iron and Steel Institute, the Institution of Mining and Metallurgy, and the Institute of Metals, and so on. These organisations are already in existence and consist of the mixture of men of the laboratory and of the works which would possibly give the best results.

The setting of men to work, whether at the Front or at home, in directions specified by the Committees is a matter which I have not touched, but this letter is already too long.

T. K. ROSE
(President).

Institution of Mining and Metallurgy, June 19.

The Magnetic Storm and Solar Disturbance of June 17, 1915.

THE greatest magnetic disturbance of the present cycle of sun-spot activity, which commenced in March, 1914, and the most violent since that of September 25, 1909, occurred on June 17, 1915. It commenced G.M.T. 1.50 a.m. with a sudden increase of H.F., and a corresponding sharp, though slight, movement of the declination needle towards the west. The greatest angular range in declination was 91·5′ of arc, which occurred at 6 p.m. The spot of light on the recording drum of the H.F. gradually swung downwards with decreasing force, until at 7.35 a.m. it passed beyond the limits of record, and remained off for thirty-seven minutes. It then returned for a moment, when a further sharp decrease took it beyond the limits of record until 11.30 a.m. Then with a succession of oscillations it increased, attaining a maximum of angular displacement of 100′ at 4.15 p.m. ($1' = 0{\cdot}44 \times 10^{-5}$ C.G.S. units). The total range exceeded 130′. The V.F. also attained its maximum value of increasing force at 4.15 p.m. In all the elements the disturbance was most intense between 4 and 6 p.m., although it did not exhibit any of the very rapid oscillations sometimes characteristic of such movements. A second phase, or repetition of the storm, consisted, as so often happens, of a few isolated well-marked swings in the form of peaks on the photographic records of all the elements. One occurred between 10.30 and 11.25 p.m. on the declination, the magnet swinging east, and the range being 38′. This was preceded at 11.5 p.m. by an increase of H.F. of 31′. A second peak was recorded on this element at 1.45 a.m. on June 18, the force decreasing by 11′. A small decrease of V.F. accompanied this movement of the H.F.

The sun's surface, though disturbed, had been almost free from spots between June 5–11. But from June 12, when a group of spots appeared in bright faculæ at the east limit, and almost on the sun's equator, the solar surface became very active with spots, bright faculæ, pores, and drifts of granulations. Individually the spots were not very large, but on June 17–18 there were no fewer than seven groups of spots visible, all displaying considerable changes of form. In particular there were two sympathetic groups, one, already referred to, extending in latitude from $+1\cdot5^{\circ}$ to $+4^{\circ}$, and in mean longitude 35°, and the other in latitude -17° and longitude 46°. The whole region of the sun between these two groups was very active, the faculæ being visible even at the centre of the disc, with streams of granulations connecting the two groups. On June 17 the southern group passed the central meridian, and the northern group on June 18. The heliographic latitude of this northern group was almost exactly that of the earth as projected on the sun, so that on June 18 the spot group and the earth were radially opposite one another. Such a close approximation of the position of the spot and the earth referred to the sun's central meridian during a magnetic storm is very unusual. It certainly has not occurred in any violent magnetic storm since the year 1898. A. L. CORTIE.

Stonyhurst College Observatory, June 20.

Man's True Thermal Environment.

FOLLOWING Dr. Hill's article on healthy atmospheres in NATURE of April 22, a letter appeared in NATURE of May 6 under the above heading, which suggests that too narrow a view has been taken of this important subject. Dr. Milne writes from a place where man exists in spite of the climate, and no doubt the robustness of the local race is largely due to generations of selection under rigorous conditions that are only overcome with the aid of ponderous clothing and heated dwellings. At the outset we should inquire as to the thermal conditions that existed at the birth of our race. No doubt man soon learnt to keep himself warm by artificial means, but he appeared first in association with a fauna almost tropical in character. It is in tropical regions that our race exists to-day in comfort with little or no protection and in spite of many adverse organisms that are also favoured by warmth.

What results would Dr. Milne's psuchrainometer give us in these places? For it is of importance if figures of any value are to be obtained that the methods should be generally applicable to habitable regions. It is not remarkable that methods bred in an extreme climate must fail in quite congenial regions but where the air temperature is often over 38° C. and sometimes exceeds 45° C. Here, no doubt, Dr. Milne's ingenuity would produce a metapsuchrainometer to tell us what heat must be taken from a body to keep it at blood-heat. We should be the richer for a valuable device, but our knowledge of man's true environment would not be much advanced.

Meteorologists have succeeded very well in obscuring the significance of the wet-bulb temperatures by wrapping them up in terms of relative humidity. The relation of the dry- and wet-bulb reading, besides giving us the potential cooling power of the atmosphere as it affects a moist surface, enables us to arrive at the absolute humidity and the specific heat of the air. This last factor no doubt varies considerably with the moisture content, and must be of importance in the convection affecting the heated body of the psuchrainometer.

Dr. Milne's ψ only takes into account the air temperature, specific heat and velocity, provided radiation effects are constant. It cannot be taken to represent the whole environmental effect, which depends also on the power of the air to take up moisture. The katathermometer figures appear most promising in this respect, but the present form of instrument is probably not completely suitable for hot climates.

G. W. GRABHAM.

Khartoum, May 26.

A Continuous Spectrum in the Ultra-Violet.

THE following observation may be of interest in connection with Prof. E. P. Lewis's letter in NATURE of June 10.

During some recent experiments which I carried out in the Cavendish Laboratory, it was observed that the radiation coming from the gas in the path of the discharge between a Wehnelt kathode and an iron anode was rich in ultra-violet light. The strength of the discharge current was between one and two amperes. With air in the bulb and the pressure reduced as low as possible with a Geryk pump, the spectrum, which was photographed with a small Hilger quartz spectrograph, showed the nitrogen bands and the mercury line λ 2536. As the pressure was increased by admitting a small quantity of hydrogen a continuous spectrum made its appearance, the mercury line increasing in intensity relatively to the bands. By washing out the bulb several times with hydrogen and removing the air by means of charcoal and liquid air, a continuous spectrum was obtained which showed no signs of the bands and lines. The spectrum extended beyond λ 2000 and gradually faded away, due to the absorption in the spectrograph. The pressure of the hydrogen in the bulb was about 2 mm.

It is thought that this continuous spectrum is the result of the bombardment of the hydrogen molecules by slow-moving electrons, the energy of which is not sufficient to produce ionisation in hydrogen. Further experiments are necessary to test this idea, and I hope to be able to carry them out on my return to America. JAMES BARNES.

The University, Manchester, June 19.

The Names of Physical Units.

To all who are interested in the improvement of scientific nomenclature the points raised by Dr. Guillaume's letter (NATURE, June 17, p. 427) are of great importance. In my opinion the case for rational nomenclature has been stated with both logic and humour by Dr. Guillaume, while Dr. Harker's reply seems to show misapprehension of the main point. All good nomenclature should be unambiguous, and, if possible, self-explanatory. The terms *masse volumique, volume massique,* and *stéradian* have both these desirable qualities; no one with a knowledge of physics and French could make any mistake as to the exact meaning of the first two, and the meaning of the third should be at once self-evident to anyone who knows the definition of a solid angle. I should not expect a chemist or a botanist to have anything but a hazy idea of the meaning of *puissance massique,* but even to an ordinary French engineer it should convey its meaning instantly.

An expression of this kind, far from being an "eccentricity," is a triumph of nomenclature. It *is* possible to mould language by logic; it is the only way to mould language that shall be truly scientific. It is this method which has given such power of expression to the French language, not only in its magnificent modern prose, but more especially in its incomparable clearness when used for the exposition of science. Though our own language is somewhat less pliant, we cannot do better than imitate our more logical and enterprising neighbours in replacing confusing or ambiguous language by clear and rational terminology. ALBERT CAMPBELL.

Teddington, June 19.

Training for Scientific Research.

I SHOULD like to say in regard to my letter on the above subject in NATURE of June 17, that, owing to exceptional circumstances, I had not read Prof. W. H. Perkin's presidential address to the Chemical Society which appeared in the Journal of the society for April, in which he makes precisely similar suggestions. This was unknown to me at the time of writing, and naturally I am very glad to find myself in agreement with so influential an authority. I can only add my hope that he, furnished with all the qualifications for the task, will succeed in persuading the universities to a reform upon which so much depends, and for which the time is favourable. T. S. PATTERSON.

Organic Chemistry Department, University of Glasgow, June 20.

Extinguishing Fires.

IN reference to Sir W. A. Tilden's article in NATURE of June 10, may I direct attention to the fact that an ordinary syphon of "soda-water" is a very effective fire-extinguisher if used in the early stages of an outbreak due to bombs, etc., and it is a wise precaution to keep a supply, of the larger size, in readiness.

A small piece of rubber tubing may be slipped over the nozzle in order to direct the discharge, or the syphon may be inverted whilst held in the hands.

C. CARUS-WILSON.

June 14.

THE SYNTHETIC PRODUCTION OF NITRIC ACID.

THE recent pronouncement of the German Chancellor, and the statements which have appeared from time to time in the daily Press and in technical journals, respecting the enormous extension in the methods of transforming atmospheric nitrogen into ammonia and nitric acid, which are claimed to have been developed by German chemical engineers, have attracted such widespread attention at the present time on account of the necessary employment of this acid in the manufacture of explosives, that it may not be uninteresting to explain shortly, and in general terms, the main principles of the methods by which such transformation is effected. The actual details of the manufacturing processes now employed in Germany have not been published, and are not likely to be made known for some time to come. But there is little doubt that these processes are, in the main, merely extensions or refinements of methods already established, and in more or less successful operation, at Odda, Notodden, and Christiansand in Norway, at Legnano, near Milan, at La Roche-de-Dame, in the south of France, and at Niagara Falls. Even before the outbreak of the war, factories for the utilisation of atmospheric nitrogen in the manufacture of synthetic ammonia and nitric acid were at work in Westphalia, at Knapsack, near Cologne, at Spandau, and in one or two places in Austria-Hungary. Similar works have been erected, or are in course of erection, in the United States, Switzerland, and Japan.

Although a considerable amount of British capital has been invested in Norwegian enterprises, no attempts have hitherto been made in Great Britain to utilise the vast stores of potentially combined nitrogen which exist in the air. It has been calculated that the air over a dozen acres contains as much potential nitric acid as is annually exported in the form of Chile saltpetre. The apparent apathy of the British manufacturer is probably due to the circumstance that hitherto we have not suffered to any appreciable extent from any shortage of nitrates or nitric acid, and that, so long as we have command of the sea, we are not likely to suffer for some time to come. But it must not be forgotten that the supply of Chile saltpetre is not inexhaustible. The rich deposits of Tarapaca are already worked out, and what is now obtained from the more inaccessible districts of Antofagasta, Toco, and Taltal is of much lower quality. On the other hand, we gather from the Chancellor's statement in the Reichstag that the new industry in Germany is to be protected for at least a number of years, which would seem to imply that the manufacture cannot be worked on ordinary commercial lines. The probable effect of protection would be to limit, if not altogether to destroy, the importation of Chile saltpetre into Germany, and thereby to diminish its price to us unless German syndicates manage to obtain control of the workings.

Another reason for the apparent lack of enterprise on the part of the British chemical manufacturer is the assumption that hitherto the commercially successful working of all such synthetic processes would seem to depend upon cheap water-power, of which this country has no very ample store. But it may be doubted whether this disadvantage is altogether insuperable, at least under certain conditions. At all events, it is certain that the German engineers have to look to other sources of energy. What will be the ultimate effect on the price of nitric acid remains to be seen. In the meantime, it is probable that its present cost to Germany is far higher than to us.

The new methods of making nitric acid from atmospheric nitrogen are twofold in character; either direct, that is, by the direct combination of nitrogen and oxygen, or indirectly through the intermediate production and subsequent combustion of ammonia. The direct formation of ammonia by the union of its elements, nitrogen and hydrogen, has frequently been attempted, but hitherto with very limited success. It has long been known that small quantities of ammonia may be formed by the action of high temperatures, say by the passage of electric sparks, on a mixture of hydrogen and nitrogen. But the reaction is necessarily incomplete, since it belongs to the class known as reversible, and in ordinary circumstances the yield of ammonia is wholly incommensurate with its cost. But it was found by Haber that when a mixture of 1 part of nitrogen and 3 parts of hydrogen, under a pressure of 175 atmospheres, is heated to about 550° in presence of a catalyst, about 8 per cent. by volume of ammonia is formed, which may be isolated by passing the products through a refrigerating apparatus, the uncombined gases being returned to the compression chamber.

The catalyst first used by Haber was osmium, a comparatively rare metal belonging to the platinum group. Later, finely powdered uranium was employed. Much experimental work has been spent in the effort to find other and cheaper catalysts, in studying the influence of temperature and pressure upon the yields, and in overcoming the technical difficulties inseparable from the construction of apparatus of large size capable of withstanding such high pressures as, say, a couple of hundred atmospheres.

The nitrogen is obtained from the air by the use of a Hampson or Linde liquefying apparatus, and subsequent fractionation on Claude's system; the hydrogen is made by passing steam over red-hot iron or heated coke. The ammonia is converted into nitric acid by oxidation under the influence of a catalyst. The same principle is adopted in the method of Ostwald, by which ammonia, obtained from "nitrolim," or, as it is called in Germany, "Stickstoffkalk," by a process to be described later, is mixed with air and passed through iron tubes into a chamber containing the contact-agent. The resulting products are led to a condensing plant, whereby, by suitable arrangements, which cannot be here described but are well known, it is claimed that from 85 to 90 per cent. of the theoretical yield of nitric acid can be obtained of a strength and purity suitable for the manufacture of explosives. The Ostwald process has been worked for some time at Gerthe, near Bochum, where it is said to have produced upwards of 1800 tons of nitric acid annually; but the experience of other countries where it has been in operation has been far less favourable, and it is doubtful whether a single Ostwald plant is now in use outside Germany.

Up to the present time, the most successful of the factories which have been established for the utilisation of atmospheric nitrogen would appear to be that of the North-Western Cyanamide Company, at Odda, on the Hardanger Fiord, Norway. This concern, which is largely financed by British capital, is operated by electrical energy furnished by a water supply capable of producing 80,000 horse-power. This factory and the associated Alby works together produce calcium carbide, and "nitrolim," a mixture of calcium cyanamide and carbon. Pure nitrogen is obtained from the air by a Linde plant driven by a 200 horse-power electric motor, and capable of producing 13,000 cubic feet of nitrogen per hour. This gas is caused to react on calcium carbide (made by fusing lime with Welsh anthracite in electric furnaces) in electric retorts heated to a temperature of 800°. "Nitrolim," by treatment with superheated steam, yields calcium carbonate and ammonia, which latter substance can be converted into nitric acid by combustion, as already stated.

The methods for the direct combination of nitrogen and oxygen to form nitric acid depend upon a reaction first pointed out independently by Priestley and Cavendish upwards of 130 years ago, and further elaborated, towards the close of the last century, by Sir William Crookes and Lord Rayleigh, who established the theoretical principles upon which the reaction proceeds. They showed that under the influence of a high temperature, produced by electric sparking, or by the passage of a strong induction current, oxides of nitrogen, and ultimately nitric acid, were formed in notable quantity. Indeed, it was in the course of the experiments which served to establish the composition of water that Cavendish incidentally discovered the true nature of nitric acid. But, as the history of science so frequently reveals, although the fundamental discovery was made by English observers, it was left to foreign technologists to turn it to practical account. This was first accomplished by Birkeland and Eyde in 1903, who established a factory at Notodden, in Norway. In their process, air is driven by a Roots blower through a powerful arc flame, operating in a magnetic field, in a specially constructed furnace. At the high temperature of the flame (3000°–3500°) about 1 per cent. of nitric oxide is formed, equal to about 30 milligrams of nitric acid per litre. The actual volume of air operated upon in each furnace is nearly 800,000 litres per minute, and in all about three dozen furnaces are in use. The nitric oxide thus produced is rapidly cooled, when it combines with a further amount of oxygen in the escaping gases to form nitric peroxide, which by treatment with water in absorption towers is changed into dilute nitric acid, to be subsequently concentrated or converted into nitrates.

Various modifications in the mode of producing the arc flame, either with or without a magnetic field, have been introduced by German and Russian engineers, and different methods of absorption and concentration of the acid have been suggested, but the essential principles of the processes are practically identical in all of which published accounts are at present available.

It will be seen from the foregoing statement that the Germans have by no means an exclusive monopoly in the production of synthetic nitric acid, and there is no reason to believe that the modifications they have been able to make in pre-existing processes not of their own invention have placed them in an independent or greatly superior position. It must be remembered that they are at present driven to work under abnormal and utterly uneconomic conditions, and it remains to be seen how far they will be able, as a manufacturing nation, and in face of the world's competition, to make good their boast that they have rendered themselves permanently independent of outside supplies of nitrates. Their strenuous labours, under the sharp spur of necessity, will at least serve to demonstrate what is to be the ultimate future of synthetic ammonia and nitric acid.

THE ROYAL DUBLIN SOCIETY.[1]

THE history of the Royal Dublin Society is that of an extensive and efficient group of educational institutions, which still cluster, in appropriately classical buildings, round about the adorned at this period with the handsome public buildings which remain its chief glory at the present day. Wealthy residents occupied town-houses, decorated internally in the most exquisite Georgian taste; among these, Lord Kildare, afterwards first Duke of Leinster, built a mansion on the eastern margin of the city in 1745. In 1814 the Royal Dublin Society purchased this building, and obtained a habitation worthy of the position it had gained (Fig. 1).

Thus, by private enterprise, a great institution for the promotion of applied science had grown up in Dublin. It must be remembered, however, that its members had considerable influence; they included a large part of the Irish House of Lords, and the meeting for the first election of members,

FIG. 1.—Conversation Room, ground floor of Leinster House, Dublin. From "A History of the Royal Dublin Society."

residence of the Dukes of Leinster. The founders of the "Dublin Society" in 1731 were anxious to improve in every way the condition of Ireland, by encouraging "husbandry, manufactures, and other useful arts." The atmosphere of Dublin was at that date eminently progressive. London was reached by a drive to Dalkey Sound, a crossing of very doubtful duration in a sailing-packet to Anglesey, and a journey of some days by chaise and coach, including the troublesome passages of Beaumaris sands and Penmaenmawr. London, moreover, was then a city to be rivalled rather than envied, and the Irish capital became in 1750, after the society had received its royal charter (p. 76), was held in the Parliament House in College Green. The Irish Parliament (p. 209) was always ready to acknowledge and assist the work of the society, and—though Mr. Berry does not mention the fact—the purchase of the Leskean collection of minerals for the benefit of Irish students (p. 156) was made possible by the zeal of the Speaker, John Forster, and by a vote from public funds.

The story of this collection, which is the basis of that now in the National Museum, illustrates the attitude of the society towards scientific work. Karsten's original German catalogue was translated and published in Dublin as a permanent

[1] "A History of the Royal Dublin Society." By H. F. Berry. Pp. xv + 460. (London: Longmans, Green, and Co., 1915.) Price 15s. net.

guide. Prizes amounting to 100*l.* per annum were offered to students of mineralogy, and these students were advised to attend instruction in the "adjoining Elaboratory" of the professor of chemistry appointed by the society.[1] This was in 1792, when practical work in natural science was far from the thoughts of the boards of studies in our universities.

It may truly be said that this chemical "elaboratory" was the precursor and foundation of the Royal College of Science for Ireland, which has just entered its new and dignified home in the rear of Leinster House. The society's library (p. 170), which dates from 1731, similarly gave birth to the National Library, now greatly extended and developed under Government control. The society's museum has, moreover, expanded as the National Museum, which now includes as a unique feature the archæological collections of the Royal Irish Academy.

FIG. 2.—View in the Botanic Garden, Glasnevin, Dublin. From "A History of the Royal Dublin Society."

The Botanic Garden at Glasnevin, on the plateau north of the city (Fig. 2), was established with Parliamentary assistance in 1751. It passed into Government control, with other offspring of the society, in 1878.

Mr. Berry brings to this work a rare combination of sympathetic insight and statistical ability. His grouping of subjects into separate chapters has great convenience, and that on "Finances and By-Laws" is of historic interest for the present members. It was in the nature of things that the grant of 15,000*l.* made in 1800 by the Irish Parliament should have been reduced after the Union to little more than 5000*l.* The real recognition of the public work of the society by the Imperial Government dates from the transfer of many of its functions to the State, after somewhat stormy negotiations, in 1878. The society is now housed at public expense, like its kinsmen in Burlington House in London, and the new lecture-theatre, one of the most perfectly fitted auditoriums in our islands, received a special grant of nearly half its cost.

The Registrar, Mr. R. J. Moss, contributes valuable chapters on the more recent progress and the scientific work of the society. A fine, if ungrammatical, old rule (p. 17) was "that every member of this society, at his admission, be desired to choose some particular subject, either in natural history, or in husbandry, agriculture, or gardening, or some species of manufacture, or other branch of improvement, and make it his business, by reading what had been printed on that subject, by conversing with them who made it their profession, or by making his own experiments, to make himself master thereof, and to report in writing the best account they can get by experiment or inquiry relating thereunto." This rule appears to be no longer laid before candidates for election, and it is no secret that the exceptionally fine premises and the lending library of the society induce many persons at the present day to become members who have no conception whatever of the historic dignity of the body which accepts their annual fees. None the less, as Mr. Berry and Mr. Moss clearly show,

[1] "Description of the Minerals in the Leskian Museum" (1798), p. ix., and R. Kirwan, "Elements of Mineralogy" (1794), p. ix.

the special scientific meetings and publications of the society represent a mass of solid research, which is recognised by an exchange-list (p. 370) that includes nearly 500 institutions.

Both Edinburgh and Dublin probably realise that it is hard to persuade workers in London to give the same attention to their publications as would be given to those of, say, Bordeaux or Bukarest; but the excellent facilities for rapid and effective publication fortunately retain a representative output for these capitals. The attempt that was at one time made to convert the Royal Dublin Society into the "Royal Society of Dublin" seems to have been based in a misconception of its primary functions, and the change would undoubtedly have minimised the important difference between the work of the society and that of the Royal Irish Academy. But from the first the society's promoters realised that industrial progress must be based on scientific observation, and they prepared the way for that union of research with technical instruction which is the foundation of the most popular Government department in Ireland at the present day.

The production of this handsome volume is largely due to the interest and munificence of the late President, Lord Ardilaun, whose portrait appropriately appears in it. The portraits as a whole are of considerable interest, and include a characteristic photograph of one of the most lovable of men, the late George Johnstone Stoney. We have made no mention of the society's early and continuous encouragement of art, resulting in the present art-school; but, as we have hinted, the whole history is that of intellectual, as well as industrial, progress throughout Ireland. The book has few misprints and few omissions. We do not know whether Mr. Berry is serious when he writes on p. 116, "a figure taken from a book entitled 'The Sorrows of Werter.'"

DR. J. W. JENKINSON.

IN Dr. J. W. Jenkinson, whose death in Gallipoli we announced last week, science has lost a devoted and distinguished son. His friends in Oxford had scarcely realised that he had reached the Front when news came that he was killed in action on June 4. A keen member of the Oxford Volunteer Training Corps he applied for a commission, though over age, and joined the 12th Worcestershire regiment in January last. He was promoted to a captaincy on April 1, and on May 10 left for service in the Dardanelles, being one of a draft of six officers from his regiment attached to the 2nd Royal Dublin Fusiliers.

Born in 1871, John Wilfred Jenkinson came up to Oxford from Bradfield College in 1890, gaining a classical scholarship at Exeter College. As a boy at Bradfield he had taken keen interest in the botany of the district, and several of his finds are recorded in Druce's "Flora of Berkshire." At Oxford, after following the line indicated by his entrance scholarship and taking honours in the Classical Schools, he turned to zoological science. For some time he studied zoology at University College, London, under Professor Weldon; and then, returning to Oxford, soon joined the teaching staff of the Department of comparative anatomy. He became a doctor of science in 1905, and in the following year was made university lecturer in comparative and experimental embryology. Exeter College elected him to a research fellowship in 1909. In 1905 he married Constance Stephenson.

Embryology was, almost from the first, the branch of zoology which held most attraction for Jenkinson. His first published research was on the "Early Stages of the Development of the Mouse" (*Quart. Journ. Micr. Sci.*, 1900), partly the result of work done at Utrecht in the laboratory of the illustrious Dutch zoologist the late Prof. Hubrecht. Since then various papers have appeared from his pen, dealing chiefly with early development, the placenta, and the origin of the mammalian ear-bones. In 1913 he brought out an excellent text-book on "Vertebrate Embryology," containing an account of the history of the germ-cells, the formation of the germ-layers, and the development of the placenta.

From the study of normal development he soon passed to the more stimulating field of experimental embryology, a science of recent growth, up to that time scarcely studied in this country. Several important papers giving the results of experimental researches were published in the *Archiv f. Entwickelungs-mechanik, Biometrika,* and the *Quart. Journal of Microscopical Science.* Jenkinson is, however, perhaps best known as the author of the first comprehensive English text-book on experimental embryology ("Experimental Embryology," Oxford 1909). This useful book is an able critical and well-reasoned summary of practically all that had been written on the subject up to the date of its publication. It will long endure as a worthy monument of his fruitful scientific labours.

The premature loss of such a promising scientific worker will be felt not only in Oxford, but also throughout the scientific world. His death brings home to us the irreparable waste to which the war has condemned Europe; and it is, alas! likely to be but one of many such losses. Those are not seldom the readiest to sacrifice themselves who have the most to give. Jenkinson's patriotic ardour, his signal energy in duty, will stamp him in the admiring memory of friends and colleagues. To die fighting for a noble cause was the end most fitting to a life wholly devoted to the highest ideals. He was gifted with indomitable courage and great powers of endurance in the presence of difficulties. These and other qualities he spent ungrudgingly for twenty years in the cause of science and for the last few months in the service of his country.

NOTES.

MR. LLOYD GEORGE, the Minister of Munitions, stated in the House of Commons on June 17 that he had been in communication with the Secretary of State for War with reference to the appoinment of a small advisory body of men of science to advise the Government during the continuance of the war as to the fullest employment of all the resources of chemical and mechanical science and invention in aid of military operations. Such a committee, if rightly constituted, should be of service in expressing opinions upon suggested means of offence or defence, but what is wanted is a working department of the War Office to organise and use the scientific and expert knowledge of the country in much the same way as the medical forces have been organised by Sir Alfred Keogh. The leisurely consideration by an advisory committee of proposals placed before it is not appropriate to the times, which demand immediate action by an energetic head who will not only use consultants but also organise scientific men into a corps on special service either at the Front or at home. Until this is done, it cannot be suggested that science is being fully employed in the nation's needs. We referred last week to Mr. H. G. Wells's letter to the *Times* upon the need for the mobilisation of scientific and expert knowledge to match and overcome like forces arrayed against us by Germany. In a further letter to our contemporary (June 22) Mr. Wells outlines a responsible official bureau having the same constitution and functions as those of the working department suggested above. Such a bureau with a capable director could do for the neglected scientific forces of the country what has already been done for the fighting and the medical forces. By all means let advisory committees be appointed as suggested by Principal Griffiths and Prof. Armstrong, but it is of even greater importance to have a well-informed central office which understands how to make the best use of the specialised knowledge of men of science individually or collectively, and knows the resources of laboratories and institutions available for national service. Sir Thomas Rose, in a letter which appears elsewhere in this issue, has misunderstood Mr. Wells, and our article last week, when he suggests that purely scientific investigation with no definite practical purpose is being urged. Intensive work with a definite object is as much the province of the man of science as of the inventor, and our plea is that such work should be instituted if the nation is to obtain the fullest advantage from scientific men and methods.

MUCH anxiety for inventors seems to be felt in many quarters, the idea being that brilliant schemes and devices may possibly not receive sympathetic consideration from Government officials or their advisers. In reply to a question in the House of Commons on June 22, the Prime Minister stated that the technical branches of the Admiralty and the War Office have very complete facilities for examining not merely completed inventions, but promising suggestions which by the application of trained electrical, chemical, or mechanical skill may be made effective. Mr. Asquith also took the opportunity to acknowledge the very valuable assistance received from the Royal Society in this connection, saying that the society has contributed to the Government several important inventions which it would not be in the public interest to disclose. We have no fear that any really practical suggestion or effective weapon of warfare will be overlooked at the present time, but we need more than a sorting office and consultative committees if we are to ensure the utmost gain from the application of scientific knowledge to practical problems. In an efficient system, every man and every intellect should be used in work for which they are best adapted by training and attainment. It is for the Government to see that this principle is actively applied to the organisation of our scientific forces in order to hasten the country's triumph.

AN excellent suggestion was made at a special meeting of the Institution of Mechanical Engineers on June 11 (reported in the *Engineer* for June 18) to the effect that all gauges and special tools required in the manufacture of munitions should be constructed in a special factory and thence distributed to contractors. Gauge-making is a very special art, requiring highly skilled workmen and special tools and arrangements for finishing accurately very hard materials. Very few general factories are equipped for work of this kind, and to expect such to provide their own gauges means considerable delay, which could be avoided easily by carrying out the above suggestion. The proposal was well received by the meeting, and we trust that the Minister of Munitions will take early action to carry it into effect.

To further the output of war materials in London and the surrounding districts the Ministry of Munitions has authorised the formation of a body to be called the Metropolitan Munitions Committee. The committee comprises the presidents of the Institutions of Civil, Mechanical, and Electrical Engineers, other prominent members of the engineering professions, trades, and manufactures, and representatives of the public utility services in London. It also includes representatives of the London County Council and of the London Chamber of Commerce. The committee is at present engaged, with the help of the Ministry of Munitions, in dividing London into various districts with small local committees and managers in order to collect information of the possibilities of the districts, so that the committee may report to the Ministry in what way London can help. Until further notice, communications should be addressed to the hon. secretaries, Metropolitan Munitions Committee, Great George Street, S.W.

THE value of youth as a national asset forms the subject of the leading article in *Engineering* for June 18. All the resources of the nation must be concentrated upon the overthrow of the enemy, and, naturally, a great part of the burden and sacrifice must fall upon youth. At the same time, it is wise that each unit of the public should be chosen for that function for which he (or she) is best suited, not only by reason of physical qualities, but also by mental capability. In this matter, attention should be given not only to the rank and file of our Army, but also to the qualifications of the young officers who have been, and are being, enrolled in such large numbers. A great number, indeed the great majority, of university trained young men have, in their enthusiasm, entered the ranks, and play the part of the private, the corporal, or the sergeant. Could not their services have been more efficiently utilised in our factories at the present moment? The factories now engaged on the production of war munitions should have their staffs as well filled as formerly by such young men. Many technically trained youths have already been brought back from the front to return to their positions. It is almost self-evident that, in the future, if the enormous economic strain is to be met successfully, we must have increased brain-power behind the manufactures of this country, and there is certain to be a greater call for mental capacity and activity than in the past. There certainly ought to be firm guidance brought to bear on all willing recruits to decide in what capacity they shall serve, and this control should not only be regulated by the needs of the moment, but should also take account of the future. We owe it to posterity to conserve our youth as far as possible, so that when the present generation passes away, fitting successors may be available to take their places and to carry on the traditions of our country.

THERE is an admirable article in *La Nature,* June 12, giving an account of the making of anti-typhoid vaccine in France, at the famous institute of Val-de-Grâce. English doctors and pathologists have long known and honoured the names of three Frenchmen—Chantemesse, Vidal, and Vincent—who have done splendid work in this great field of protective medicine; and what France thinks of them may be judged from the fact that the French Institute has just divided between them the Osiris prize of 100,000 francs. The article, by M. Benoit-Bazille, is admirably illustrated, and is easy for everybody to read and understand. The vaccine is *polyvalent* : that is to say, it is a blend, made not from one but from many strains of *Bacillus typhosus,* from diverse sources. The vaccine is sterilised : that is to say, it contains no living elements, no living germs; the sterilisation is effected by the momentary use of ether. The enforcement of aseptic methods, at every stage in the making and putting-up of the vaccine, is of the utmost vigilance. A striking example is given, with a chart, of the value of this treatment, during September-October, 1914, in the Belfort command. It is only one of many examples; but it is pleasant reading. We read with pleasure, also, of the zeal shown in the work. "Nobody but those who have lived at the laboratory from September, 1914, to the early months of 1915, can have any idea of the activity which prevailed there, and of the indefatigable zeal of all, men and women, mobilised or voluntary workers—directors of laboratories, preparators, Red Cross ladies, hospital orderlies, all working together." The whole article is excellent; and we gladly commend it to our readers.

WE are glad to learn that Dr. H. McLeod, F.R.S., director of the Royal Society's Catalogue of Scientific Papers, who has been seriously ill for some time past, is now much improved, and has been able to leave home for the seaside.

THE annual general meeting of the British Science Guild will be held at the Institution of Electrical Engineers, Victoria Embankment, W.C., on Thursday, July 1, at 4 p.m., when the report of the year's work of the guild will be submitted. The chair will be taken by the president, the Right. Hon. Sir William Mather, P.C., and an address will be given by Sir William Ramsay, K.C.B., F.R.S.

THE sixty-seventh annual meeting of the Somersetshire Archæological and Natural History Society will be held at Taunton on Tuesday, July 20. The meeting will afford members of the society an opportunity of inspecting the museum and buildings at Taunton Castle, and to see the improvements and additions effected in the Castle since the society's diamond jubilee celebration at Taunton in 1908.

IN place of the usual long excursion to the provinces the Geologists' Association proposes to organise a series of day excursions from London between August 25 and September 5. Mr. W. Whitaker, the chief director, will be assisted by the president of the association (Mr. G. W. Young), and other geologists. These excursions will afford provincial members opportunities of visiting the numerous fine sections easily accessible from the metropolis. As opportunities arise attention will be directed to the causal connections between the geology and geography of the various localities. The series of excursions will form a fairly complete demonstration of the field geology and geography of the London district.

THE Glass Research Committee of the Institute of Chemistry has found that a glass such as that made from formula No. 10, recently published by the institute (see NATURE, April 15) and recommended for X-ray bulbs, does not give a green phosphorescent glow if it is made from approximately pure materials. The slight glow given is blue. In view of the fact that a green phosphorescence appears to be preferred by users of X-ray tubes, it seemed desirable to determine the conditions for obtaining this effect. It has been traced to the presence of manganese; and such a glass as No. 10 will give this green glow when manganese dioxide is added to the batch mixture in the quantities frequently used to correct the colour due to iron.

AN address delivered by the distinguished astronomer, M. Camille Flammarion, on German mentality in history, has been printed, together with an appeal to the United States on behalf of Belgium ("La Mentalité allemande dans l'histoire," by C. Flammarion; Paris: E. Flammarion, 1915; price 50 centimes). M. Flammarion takes a broad view of the world-war convulsing one small planet in an infinity of other and greater worlds, and represents it as a struggle between civilisation and barbarism. A section of interest to scientific readers is that in which he shows the German or Prussian traits of arrogance and brutality to have been recognised throughout history for nearly 2000 years. It can be no coincidence that Julius Cæsar, Velleius Paterculus, Seneca, Tacitus, Strabo, tell the same tale as Froissart in the Middle Ages. Prussians to-day, like the Prutzi of the tenth century, are ethnically Finno-Slavs. The dependence on ethnical bases of such different national characters as those of the French and the German should be worth full investigation.

HITHERTO the only evidence of Neanderthal or Mousterian man from Spain has been the small skull in the Royal College of Surgeons, which was discovered in a cavern at Gibraltar in 1848. A typical lower jaw has now been recognised by Drs. Hernández-Pacheco and H. Obermaier, who describe the specimen in Memoir No. 6 just published by the *Comision de Investigaciones Paleontológicas y Prehistóricas* at Madrid. The newly-described jaw was found in 1887 at a depth of about five metres in a bed of tufa deposited by a former extension of the small lake of Bañolas in northern Catalonia, about 23 kilometres N.N.W. of Gerona. It was associated with non-marine shells and fragments of plants, but with no remains of importance for determining its precise geological age. The specimen is completely fossilised, but so fragile that it cannot be reproduced as a plaster cast. It retains all the teeth, and seems to belong to a male about forty years old. The body of the bone is low and stout, as usual, without any prominent chin; the ascending ramus is broad, with a shallow sigmoid notch. The teeth are relatively large, and all except the last molar are much worn by mastication. The incisors are somewhat inclined forwards. The roots of the molars are unfortunately obscured, and their characters have not been determined by radiography.

A LIST has just been published of all pensions granted during the year ended March 31, 1915, and payable under the provisions of the Civil List Act, 1910. Among the pensions we notice the following relating to scientific services:—Mr. G. Coffey, in recognition of the value of his researches and writings on Irish archæology, 100*l.*; Mrs. J. E. Baker, in consideration of the services of her husband, the late Dr. Hugh Baker, in the investigation and treatment of sleeping sickness in Africa, 80*l.*; Mrs. C. E. Burch, in consideration of the value of the researches of her husband, the late Dr. G. J. Burch, in physics and physiology, 60*l.*; Miss A. H. Bollaert, in recognition of the contributions of her father, the late Mr. William Bollaert, to the study of history, archæology, and ethnology in Spain, Portugal, and South America, 50*l.*; Miss L. Hunting and Mr. F. C. Hunting (jointly and the survivor of them), in consideration of the services rendered to veterinary science and practice by their father, the late Mr. W. Hunting, 50*l.*; Mr. W. G. Wallace and Miss V. Wallace, in consideration of the scientific work of their father, the late Dr. A. R. Wallace, 50*l.* each; Dr. Charlton Bastian, in consideration of his services to science, 150*l.*; Mr. R. H. Rippon, in consideration of his contributions to natural history, and of his inadequate means of support, 100*l.*; Dr. Marshall Watts, in consideration of his scientific work, 75*l.*

THE President of the Board of Agriculture and Fisheries has appointed a Departmental Committee to consider and report what steps should be taken by legislation or otherwise for the sole purpose of maintaining and, if possible, increasing the present production of food in England and Wales, on the assumption that the war may be prolonged beyond the harvest of 1916. The Committee will be constituted as follows:—The Right Hon. Viscount Milner (chairman), the Lord Inchcape, the Right. Hon. F. D. Acland, Mr. C. W. Fielding, Mr. A. D. Hall, Mr. Rowland E. Prothero, Mr. J. A. Seddon, the Hon. E. G. Strutt, and Sir Harry C. W. Verney, Bart. The secretary of the Committee will be Mr. H. L. French, of the Board of Agriculture and Fisheries, to whom all communications should be sent. The Committee has been appointed for the specific purpose defined in its terms of reference, and it has been asked, should it find that additional powers are necessary, to report in time for legislation to be submitted to Parliament during the present session. Its functions are quite distinct from those of the Agricultural Consultative Committee appointed by Lord Lucas on the outbreak of War. The Consultative Committee is a permanent Committee, to which the Board refers many subjects connected with practical agriculture, and no alteration in its work or constitution is contemplated; it will continue to advise the Board throughout the duration of the war.

IT is very comforting to note that a strong committee appointed by the Institute of Chemistry and the Society of Public Analysts and Other Analytical Chemists has taken in hand the very important problem of the standardisation of chemical products with special reference to their purity for analytical purposes, and that it has published a booklet entitled "A List of Reagents for Analytical Purposes, with Notes indicating the Standards of Purity regarded as Necessary for Analytical Work." The committee suggests that manufacturers should add the letters A.R. (signifying Analytical Reagent) to those of their products which conform to this standard. This matter has been dealt with for many years past by the larger factories in Germany, and one cannot help but feel that the letters A.R. are scarcely an efficient substitute for the very imposing label which is affixed to similar products emanating from Berlin, and which bears, over the signature of Dr. Bischoff, a list of some half-dozen substances which are not present, and finally the statement, "Gehalt—99·99 per cent." However, a very definite step has been taken in the right direction, and the committee is to be congratulated on the manner in which it has tabulated the various analytical reagents, and has stated the tests by which the purity of each of them may be determined. It is sincerely to be hoped that manufacturers will fall in with this scheme and that they will see that their reagents conform in all cases with the standard required. It cannot be denied that the reason which, in the past, has caused chemists to rely upon German sources for their reagents is to be found in the absolute trustworthiness which could always be placed upon the products emanating from such firms as those of Kahlbaum or Merck. The English manufacturers have now the opportunity to show that equal trustworthiness can be placed on their products, and that the initials A.R. attached to their reagents imply that they are Absolutely Right.

THE *National Geographic Magazine* for May again publishes a valuable contribution to the study of the great war by two timely articles. Mr. H. G. Dwight writes on the gates to the Black Sea: the Dardanelles and the Bosphorus, and Mr. E. A. Grosvenor on Constantinople and Sancta Sophia. The letterpress is interesting, but it is little more than an accompaniment to a fine series of photographs which illustrate in an admirable way the difficult conditions under which the present campaign is being conducted.

So much has been written on the subject of eoliths and of the Piltdown skull, that, in the existing state of the very active controversy which is being conducted on these questions, it is, for the present, inadvisable to discuss them in these columns. Meanwhile, the attention of British archæologists may be directed to an important memoir, occupying sixty-three pages, contributed by M. M. Boule to the issue of *L'Anthropologie* for January–April, 1915. He sums up the latter question by remarking:—"Les documents de Piltdown sont malheureusement des documents incomplets. Leur interpretation est encore douteuse sur des points essentiels. Ils constituent, malgré tout, une découverte des plus importantes et des plus instructives."

IN a paper read before the Royal Society of Medicine (Pathological Section, May, 1915) Dr. Charlton Bastian directs attention to the use of tyrosine as an aid in the demonstration of the "de novo" origin of living organisms (see NATURE, December 14, 1914, p. 466, and January 22, p. 581). He finds that a 0·05 per cent. solution of tyrosine in the proportion of thirty drops to each fluid ounce of his culture fluids accelerates the appearance of the organisms. The tyrosine should be added *after* the culture fluids are ripe for examination, the mixture being examined after three to four weeks' further incubation subsequent to the addition. When added at the time of preparation of the culture tubes, this action was not observed.

THE additions to the menagerie of the Zoological Society of London during the month of May numbered 136, among which were four Siamese fighting-fish (*Betta pugnax*) from Siam, new to the collection. Having regard to the abnormal conditions under which we are now living it is gratifying to notice that while the receipts for admission during this year, up to the end of May, show a decrease of 1189*l*., as compared with the corresponding period in 1914, there is an increase of 266*l*., as compared with the corresponding period of the previous ten years.

IN the columns of the *Times* of June 17 especial attention was directed to the fact that a litter of pine martens, "one of the rarest animals of the British Isles," was taken on June 15 among the crags below Honister Pass, in the Lake District. "Cumberland," we were informed, "is not even mentioned in the text-books on Carnivora as one of the few counties in which the pine marten is still to be found." If this be so, then the text-books need revision, for Cumberland is one of the counties in which the pine marten may now most certainly be found, though even here it is rare.

DR. G. F. KUNZ, president of the New York Academy of Sciences, has in preparation a volume on "Ivory and Elephants," and asks us to appeal to such of our readers as may be able to help him for detailed measurements of the tusks of the mastodon, mammoth, and elephant. He requires the length of the tusk along the outside curve; the circumference taken at the middle; the circumference and diameter at the socket; and the length of the base within the socket. Dr. Kunz appears already to have collected all the available published records, and hopes for help now from those who may possess as yet unrecorded specimens. Any information will be gratefully accepted, and duly acknowledged, and should be addressed to him at 409 Fifth Avenue, New York.

TWO papers which will be highly acceptable to ornithologists appear in *British Birds* for June. In the first of these Miss Maud D. Haviland records some brief notes on the breeding habits of the grey phalarope, which she had the good fortune to encounter at Golchika, on the river Yenesei, Siberia. Her notes, illustrated by some most excellent photographs, are confined to the incubation period, and show that while incubation is performed by the male alone, both sexes unite in the care of the young. Another point worthy of note concerns the coloration, which, though vivid in this species, when in the breeding dress, is yet highly protective. The second paper contains records of the recovery of a number of birds, ringed and released by members of the British bird-marking scheme. While most were recovered at or near the place of their birth, one or two had wandered far afield, as in the case of a song-thrush ringed as a nestling at The Fylde, Lancashire, on April 4, 1914, and recovered at Pontillado, Spain, on November 18. A whinchat, marked as a nestling at Ingleton, Yorkshire, on June 15, 1914, was recovered on October 4 at Loule, Portugal.

STUDENTS of magmatic differentiation in igneous rocks will find much to interest them in Mr. B. J. Jayaram's discussion of the charnockite series in south-west Mysore (Records, Mysore Geological Department, vol. xii., p. 77).

MR. H. SUTER, in Palæontological Bulletin No. 2 of the New Zealand Geological Survey, has revised the type-material of the Tertiary Mollusca of New Zealand, and the drawings prepared for F. W. Hutton's catalogues are now for the first time published. All such work tends to reduce to order the conflicting classifications that hamper stratigraphy in New Zealand.

Scientia, the international scientific review, contains in its May issue three articles by eminent politicians on the catastrophic state of Europe; but there is also an interesting review in French by M. P. Rudzki, of Cracow, on recent theories of the origin of continents, including the work of Messrs. Jeans and Love.

THE *American Journal of Science* for May, 1915 (vol xxxix., No. 223), contains several palæontological papers. We notice here one by Mr. E. W.

NOTICE.

For the convenience of readers of NATURE wishing to inspect books *published abroad* which have been reviewed in NATURE such volumes are kept for the period of six months at the publishing office of the journal. The books are retained for the purpose of examination free of charge. The display of books began with those reviewed in NATURE of January 7 last.

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Shuler on a new Ordovician Eurypterid, *Stylonurus alveolatus*, from south-western Virginia. The species occurs in marine strata, and confirms Laurie's view that the habits of Stylonurus were littoral.

IT is especially appropriate at the present time to direct attention to Mr. W. Versfeld's illustrated thesis on "The geological structure of portions of German South-west Africa," which occupies nearly the whole of the March number (vol. xi., 1915) of the *South African Journal of Science*. The region studied extends from the Orange River south of Warmbad to the dolerites and Karroo Beds of Keetmanshoop in latitude 26° 30′ S. A sedimentary origin is assigned to the gneisses near the Ham River, which consist of very distinct layers, now highly quartzose, now dark with hornblende. Although a "passage" into granite is observable, the author hesitates to regard this as an igneous contact. The Dwyka conglomerate is clearly recognised near Dreihoek, though no striated pebbles have yet been found in it.

AN article on "The European Winter and the War," by Prof. Robert De C. Ward, of the Harvard University, has been reprinted in pamphlet form from the *Journal of Geography*, vol. xiii. It deals chiefly with the period from November 1 to January 31, and is the continuation of a previous article by the same writer entitled "The War and the Weather during the First Three Months of the Fighting," noticed in NATURE of February 4 (p. 625). Referring to the western and eastern theatres of war in winter, the author states that both have advantages and both have disadvantages from a military point of view, the western having higher temperatures, and consequently more rain, mud, and "slush," whilst in the eastern war zone there is the disadvantage of greater and more continuous cold, but the advantage of somewhat more settled weather. It is mentioned that it is in the eastern war zone that there has been the greatest suffering on account of the cold, and there the winter weather controls have been most marked. In the eastern zone mild weather spells have been accompanied by an immediate slackening of military operations owing to the difficulty of transport. The author, writing from the other side of the Atlantic, says:—"The fact that this war is being fought in the winter means hundreds of thousands of dollars to the manufacturers of winter supplies in the United States." Attention is directed to the greater importance of the weather on warfare to-day than in the past, and the matter of aeroplanes and airships is instanced.

IN the Proceedings of the Tokyo Mathematico-Physical Society for 1909 and 1913 Prof. Terada and Dr. Hasegawa discussed the possibility of the barometric gradient over a region subject to earthquakes being one of the contributory causes of their production. The latter also showed that in one such district in Japan when an earthquake occurs the barometric gradient is perpendicular to the line of a certain geological fault. In the Proceedings for March and April, 1915, Dr. Nakamura shows that in the case of fifty slight earthquakes which occurred in another district in 1904, the barometric gradients were nearly perpendicular to the line of seismic weakness previously calculated by Prof. Omori by grouping the epicentres. The relation between the barometric gradient, the stress it produces in the earth's crust, and the occurrence of earthquakes seems now well established.

A CONTRIBUTION to the theory of the gyroscope is communicated to the Proceedings of the Royal Society of Edinburgh, xxxv. (2), 14. Prof. Lamb's object is to obtain briefly the *intrinsic* equations of the gyroscope, and to show how they lead immediately to the solution of a number of problems. Apart from their uses as a basis of calculation, they have a simple interpretation which enables the author to foresee the general character of the motion in cases where the actual calculation would be difficult. It is, however, to be hoped that Prof. Lamb, in addition to the applications to the gyrostatic compass and the steadying effect on ships, will bear in mind that aeroplanes present pressing demands for systematical study. Even gyroscopic action of propellers opens up a wide field for research. It must be admitted that Prof. Lamb's interpretations are very neat and simple, and to the point. A study of the paper might enable an average student to attack an examination question on the subject in an intelligent manner. With the existing treatment such questions as a rule are only answered by copying.

Science for May 7 contains an interesting article by Dr. B. C. Hesse on the part played by the chemist in the industrial development of the United States. Dr. Hesse emphasises the fact that although public attention has since the beginning of the war been centred on the chemist mainly in connection with coal-tar dyes, the industry of these dyes forms only a very small part of the total manufactures in which chemistry plays a predominating part. The entire consumption of dyes in the United States represents only about fifteen million dollars, whilst other true chemical industries represent nearly 2500 millions of dollars of produce per annum. If several others be included which are not exclusively chemical, but rest largely on a chemical basis—for example, the steel and iron industries and petroleum refining—the value of this produce is more than doubled, and the total number of wage-earners engaged increased to nearly 6¾ millions. The part played by the chemist in the United States has been a very great one, and at the present time there are nearly ten thousand chemists in the country. If he has not done more "the fault largely rests with those in charge of many of the industrial enterprises requiring chemical knowledge in their exploitation, who fail absolutely in a chemical understanding of their own products, and are devoid of any sympathetic contact with chemistry and with chemical points of view."

FROM several agricultural stations in the country publications have recently been issued showing how the deficiency of potash supplies can to some extent be met by the farmer. It was shown at Rothamsted that the ashes of hedge trimmings were practically as rich as kainit, and could be used in its stead. Mr. C. T. Gimmingham, of the Horticultural Research Station, Long Ashton, Bristol, has now directed attention to the considerable amount of waste material from the saw mills, and has made analyses showing that this also yields a residue containing from 6 to 10 per cent. of potash (K_2O). Mr. Gimmingham points out that the wood scraps, sawdust, and shavings from planing machines, etc., are produced in enormous quantities in every sawmill in the country. Some of this material, and notably the sawdust, is saleable in certain localities, but the great bulk of it is available for conversion into ash. In many cases this is already done; the wood is used as fuel, either alone or mixed with coal, and the ash is then readily obtained. It is interesting to note that in these cases the flue dust also contains a considerable proportion of potash, in one case as much as 9 per cent. being found. From the fertiliser point of view the admixture of coal with the wood is a disadvantage, and in view of the fact that the pure ash is worth anything from 25*s*. to 50*s*. per ton as fertiliser, it is well worth considering whether greater economy could not on the whole be effected by leaving out the coal and using wood waste only for fuel.

OUR ASTRONOMICAL COLUMN.

COMET NOTES.—An ephemeris of comet 1915*a* (Mellish) is published in the *Astronomische Nachrichten*, No. 4802, being a continuation of that published in No. 4801. It gives the magnitude as 5·5 on July 2, the brilliancy decreasing steadily afterwards. The comet will be a conspicuous object in July for southern observers, but its large southern declination during that month renders it unfavourable for observation in higher latitudes. Fortunately the southern declination will rapidly decrease, and the comet will be again visible in these latitudes. Dr. Crommelin, writing in *Knowledge* for June, hopes that it may still be a naked-eye object. The orbit, he says, "shows a slight resemblance to that of comet 1748 II., which was seen only on May 19, 20, and 22, in 1748, so that the elements are not very well known. Identity of the two comets is perhaps just possible, but not probable." A continuation of the ephemeris of the periodic comet Tempel 2 is also printed in *Astronomische Nachrichten* No. 4802, giving positions down to the end of next August.

ORBITS OF ECLIPSING BINARIES.—No. 3 of the Contributions from the Princeton University Observatory contains an important study of the orbits of eclipsing binaries by Dr. Harlow Shapley. It may be remembered that it was in 1912 that new methods were introduced for the computation of the orbit of an eclipsing binary, and these have permitted the rapid development of this phase of double-star astronomy. It has now become possible, as Dr. Shapley remarks, to derive as much information concerning binary systems in general, and their bearing on stellar evolution, from the orbits of eclipsing variables as from spectroscopic binaries or visual doubles. These new methods and their development are due to Prof. Russell and Dr. Shapley, and the present publication gives briefly the theory underlying the methods, and exhibits in some detail how these methods are employed in dealing with the considerable variety of problems that arise. A preliminary report in 1912 dealt with the orbits of forty-four stars, and later the results for eighty-seven stars were published. The present discussion represents the complete investigation of practically all the material available up to the present time, and contains in final form the treatment of ninety eclipsing variables. Dr. Shapley for the last two and a half years has been using the equipment of the Princeton Observatory to add to the material, and has made about 10,000 light measures with the polarising photometer. This has been done to obtain complete light curves of interesting stars, to fill up gaps in published series of observations, and to correct existing light curves. In the arrangement of the text the author has, as far as possible, kept the tabular matter separate and brought this together in the appendix. On p. 124 he summarises some suggested investigations on eclipsing binaries, and points out lines along which further investigations are desirable and could be accomplished without serious difficulty.

THE VARIATION OF LATITUDE DURING 1914·0–1915·0.—Prof. Albrecht publishes, in the *Astronomische Nachrichten*, No. 4802, provisional results of the international service for the determination of the variations of latitude. Fortunately, the war has in no way disturbed the observations at the six stations, so that the determination of the path of the pole has been continued as on former occasions. The communication is accompanied by the usual chart showing the track of the pole for the period 1909·0 to 1915·0, indicating an increase of amplitude of swing since the latter end of the year 1913.

THE SOCIETY FOR PRACTICAL ASTRONOMY.—The April-May number of the Monthly Register of the Society for Practical Astronomy, Chicago, has just come to hand. While the astronomical observations published in it are very brief, dealing only with some observations of comets and a short report on the planetary and lunar section, attention is directed to the need of a new section which should have for its object the furthering, in all possible ways, of the teaching of elementary astronomy according to modern methods. The writer of this appeal, Dr. Mary Byrd, formerly director of Smith College Observatory, refers to a circular letter issued some years ago by the American Astronomical Society, in which it was stated:—"The society considered the deplorable ignorance of persons, otherwise intelligent, in regard to everyday phenomena of the sky, and the fact that astronomy lags behind the other sciences in adopting the modern method of laboratory work by the student." As a move in the direction of remedying this defect the author advocates a scheme of organised effort to make elementary astronomy a practical study, and calls on the great body of amateurs in America to enlist themselves in the new movement.

AIMING WITH THE RIFLE.

SO many people are now learning to shoot with the rifle that it is profitable to consider some of the difficulties they are likely to meet with. These difficulties become greater as the age of the learner increases, and they may be minimised or accentuated by the lighting of the range at which the learner practises. A discussion of the lighting of rifle ranges, which took place at the monthly meeting of the Illuminating Engineering Society on May 18, shows very clearly that the existing conditions place artificial obstacles in the way of the learner; and it may fairly be contended that these obstacles never would have arisen, and the path of the learner would have been considerably smoothed, if certain optical principles had been recognised and utilised. Mr. A. P. Trotter, who opened the discussion, gave a very clear account of the difficulties encountered by a man of middle age when he attempts to shoot at one of the many indoor ranges which have recently been opened; it has appeared to me to be worth while to attempt to explain some of these difficulties, in order that those which are avoidable may be eliminated.

An experimental arrangement which can be used to illustrate the essential difficulties to be met with in aiming with the rifle, is represented in perspective in Fig. 1. A is a rough model of the eye. It comprises a tube about $1\frac{1}{2}$ in. in diameter and 3 in. long, closed in front with a lens L of about 3 in. focal length; into the back of this tube fits another tube, which carries a screen of ground glass S. B is a sheet of cardboard, with a notch in the upper edge, to represent the rear-sight of the rifle. C is a piece of card cut to a point, to represent the fore-sight of the rifle. D is a circular opaque disc which, for convenience, may be attached to the glass of a window of the room in which the experiment is conducted; this disc represents the "bull's-eye" of the target. By sliding the screen S in or out, either B, C, or D may be focussed; but all cannot be focussed at the same time. If, however, the lens is covered with a piece of card provided with a circular aperture of about $\frac{1}{2}$ in. diameter, A, B, and C can all be focussed simultaneously; and the screen S can be moved in or out through some distance without impairing the clearness of the image on the ground glass. The brightness of the image is, however, much diminished. This illustrates the advantage and disadvantage due to the use of "pin-hole" spectacles. If the card is arranged so that its circular aperture lies over the

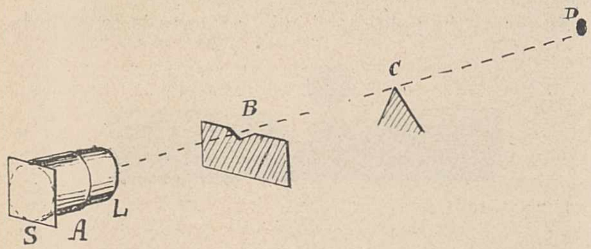


FIG. 1.

middle of the lens, and the images of B, C, and D are formed at the middle of the ground glass screen, the position of the image of either B, C, or D is identical with that of the corresponding image produced, with the card removed, by adjusting the position of the ground glass screen; but if the aperture of the card is displaced towards the edge of the lens L, the various images are displaced both relatively and absolutely.

Further, let the perforated card be removed, and let the screen S be adjusted so that the "bull's-eye" is focussed; then on covering the lens from below by a piece of unperforated card, it will be seen that as the card rises, the image of the "bull's-eye" sinks, while the images of the sights rise. A similar effect can be observed with regard to the eye. If the model eye A is removed, and replaced by the eye of the observer adjusted so that B, C, and D are in alignment, while D is focussed, it will be found that if the pupil of the eye is gradually covered from below by a piece of card the "bull's eye" appears to rise above the sights.[1] To understand this result, it must be remembered that the image produced on the retina is inverted, and that an absolute depression of the image is interpreted as an apparent rise of the object viewed. The apparent motion referred to is very marked when the light is dim and the pupil is expanded; it can only be noticed with some difficulty in bright daylight.

[1] See "Spherical Aberration of the Eye," by E. Edser (NATURE, April 16, 1903). Also "Light for Students," by E. Edser (Macmillan and Co.), p. 165.

Returning to the arrangement represented in Fig. 1, it will be found that when the "bull's-eye" is focussed by the unstopped lens L, raising the card B causes the image D to sink. Similarly, in a dim light, on bringing the rifle into position so that the rear-sight intercepts light from the lower part of the pupil, the "bull's-eye" appears to rise. In a great number of cases, when the fore-sight is brought too high so as partially to cover the "bull's-eye," the latter appears to swell at its upper left-hand edge (at about "half-past ten"), and sometimes this swelling develops into a second "bull's-eye" detached from the first one.

The following important phenomena can also be noticed:—

(1) On focussing the bull's-eye with the lens L unstopped, the image of the fore-sight C is surrounded by a narrow penumbra; a similar but wider penumbra borders the image of the rear-sight B. If the lens is now stopped down, the circular aperture of the card being over the middle of the lens, the images of B and C become sharp, and it will be noticed that *the images of the edges of the sights now have the same positions as the edges of the corresponding penumbras produced by the unstopped lens.* Thus it appears that in aiming with the rifle, when the bull's-eye is focussed, the top of the narrow penumbra surrounding the fore-sight should be brought level with the top of the wider penumbra bounding the shoulders of the V or U rear-sight. I have found that this procedure leads to consistent and good shooting. A peculiarity of the penumbra surrounding the ocular image of the fore-sight will be mentioned later.

(2) On focussing the fore-sight B with the lens L unstopped, the image of the bull's-eye D becomes much smaller, and may even disappear. The image of the rear-sight is slightly improved. Similarly, when aiming with the rifle, the image of the bull's-eye is diminished in size when the fore-sight is focussed by the eye.

(3) On focussing the rear-sight B with the lens L unstopped, the bull's-eye D disappears, and the fore-sight B becomes smaller and less distinct.

Now young people can alter the focus of their eyes without effort; they see the bull's-eye, the fore-sight, and the rear-sight in rapid succession, so that sometimes they appear to see all three at the same time. In this case sighting is easy. But with advancing age comes the necessity for effort in focussing the eye to different distances, even if this capacity is not lost altogether. For myself, I can read print (even small print) at ten inches from my eye, but a perceptible effort is required to alter the focus of my eyes; and from the result of my own experience, together with that of several men in a condition similar to my own, I strongly advise that the bull's-eye only should be focussed, the tip of the fore-sight being brought just below the bottom of the bull's-eye and level with the top of the penumbra which bounds the shoulders of the rear-sight.

A peculiarity of the image of the fore-sight, when the bull's-eye is focussed by the eye in a dim light, must now be mentioned. At first sight the appearance presented is that of three images[2] standing side by side, the central image being the darkest. On careful scrutiny, however, two overlapping images only are seen, the portion common to both being darker and giving the appearance of a third image (Fig. 2, A). No such appearance can be obtained with the model represented in Fig. 1; we must therefore seek for its explanation in some defect peculiar to the eye. With a little care a somewhat similar double image can be seen even in fairly bright daylight. Let the pointed tip of a lead pencil be placed (for steadiness) upright against the glass of a window, and then, with one eye

[2] These appear to be the three images mentioned by Mr. Trotter.

closed, look with the other eye past the pencil at some distant object; a narrow penumbra will be seen round the tip of the pencil, and on observing this carefully it will become evident that there are really two overlapping images of the pencil-tip standing side by side, the portion common to the two being dark (Fig. 2, B). The nearer the eye is to the pencil, the greater is the separation of the images; in daylight, separation is just visible (to me) at a distance of about 3 ft. If the *right* half of the pupil is now covered by a card, the *left* image disappears; on covering only the *left* half of the pupil, the *right* image disappears. If the pencil is placed in a horizontal position, the appearance is quite different; the pencil now appears sharply defined laterally, but its tip ends in a penumbra (Fig. 2, C).

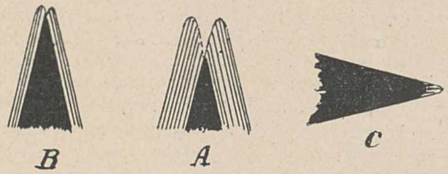
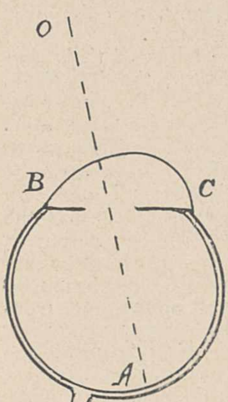


FIG. 2.

It appears to me that these phenomena may be ascribed to the peculiar shape of the cornea. It has long been known that the cornea is not spherical, and Sulzer has found that its form does not agree with any known simple surface, and that it has no axis of symmetry. In the majority of cases the nasal side of the cornea is flatter than the temporal side, so that the section of the cornea of the right eye, when viewed from above, resembles BC, Fig. 3. The visual line OA (*i.e.*, the line along which the most direct ray travels from the object O to the most sensitive portion of the retina A) passes through the flatter portion of the cornea; and the centre of the pupil is also behind the flatter portion of the cornea. Thus when the light is good, and therefore the pupil is small, the rays which form the image on the retina pass through the flatter portion of the cornea; and under these conditions we obtain the best ocular images.



Now, in aiming with the rifle in a dim light, the bull's-eye being focussed, if the cornea were spherical, there would be a number of overlapping images of the fore-sight, thus giving rise to the appearance of a single dark image surrounded by a penumbra. The peculiar shape of the cornea, however, appears to cause a segregation of these images into two groups, giving rise to two overlapping images side by side. The light which enters the right eye through the left part of the cornea (*i.e.*, the flatter portion) gives rise to the right-hand image; that which enters through the right (more strongly curved) portion of the cornea gives rise to the left image. So far as my experience goes, the right image is the darker and better defined of the two; and we might expect this to be the case, since it is formed by the rays which traverse that part of the cornea which is utilised when vision is at its best. It therefore appears that *the right-hand image of the fore-sight should be aligned with the middle of the notch of the rear sight, its tip being just below the bull's-eye at "six-o'clock," and just level with the top of the penumbra that bounds the shoulders of the V or U rear-sight* (Fig. 4). In a dim light it is well to allow for the fact that the bull's-eye is apparently raised, by leaving a distinct white line between the tip of the fore-sight and the lower side of the bull's-eye. In all cases the fore-sight should at first be aligned some distance below the bull's-eye, and raised to its final position just before firing.

When the rifle is aimed in daylight *with a bright sky overhead,* light is reflected from the upper rim of the rear-sight into the eye. When the bull's-eye is focussed, this light forms three bright linear images in the eye. The lowest bright line occupies the position of the upper boundary of the black portion of Fig. 4; the middle bright line occupies the position of the upper boundary of the penumbra shown in Fig. 4; while the upper bright line bounds a faint secondary penumbra which is scarcely visible in a dim light. Similarly, if a diaphragm with a narrow horizontal slit is placed in front of an eye focussed to see distant objects, three bright images of the slit are seen. These multiple images, which vary somewhat in position for different observers, and even for the two eyes of a single observer, are presumably due to variations of curvature of the cornea in a vertical plane. Correct shooting can be obtained by aligning the top of the fore-sight with the *central* bright line which bounds the lower penumbra; as this line is clearly seen, it can be utilised as easily as the focussed image of the rear-sight. The advantage of a good overhead light thus becomes apparent.

So far as the lighting of indoor ranges is concerned,

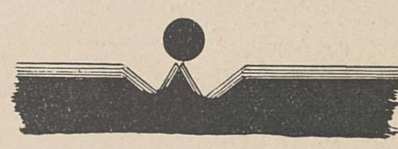


FIG. 4.

it may be inferred that we shall see best under those conditions which approximate most closely to ordinary diffused daylight. The use of a small brightly illuminated target, in a room with black walls and ceiling, could be defended only if it were desired to train people to shoot at a distant searchlight. In such conditions the pupil is distended, all of the troubles discussed above are intensified, with the addition that the glare of the target tires the eyes. Similarly, the glowing filament of an incandescent lamp tires the eye more when it is viewed in a dark room than when it is viewed in daylight. I believe that the best thing to do in connection with indoor rifle ranges would be to whitewash the walls and ceiling, and have a good illumination either with electric glow lamps or incandescent gas mantles, merely taking the precaution that the lamps are shielded (say, by paper shades) from the direct view of the shooters.

So far as the utility of miniature rifle ranges is concerned, it appears to me that this may be easily overrated. It is possible, of course, at one of these ranges to learn to hold the rifle correctly, to become accustomed to accurate sighting, and to press the trigger without moving the rifle. Difficulty, however, arises from the fact that accurate shooting entails compliance with *all three* of these requirements, and bad shooting may be due to a failure in one only. The position of the bullet-hole in the target gives only the net result of all the actions involved; and I have known men to ascribe their failure to get near the bull's-eye to the defective sights of the rifle, or (more rarely) to their own defective sighting, when in reality their bad shooting was due to *pulling* the trigger instead of *pressing* it. It is clear that more rapid progress can be made if the learner can discover the particular defect to which his failures are due. Various devices have been used for this purpose.

In the sub-target the rifle is mounted on a universal joint, and on pressing the trigger a hole is punched in a card, thus indicating the direction in which the rifle is pointed at the instant. This appliance is expensive, and since the rifle is not free, defects due to trigger-pulling are not made evident.

The aim-corrector is a piece of plain smoked glass mounted behind the rear-sight so that its surface is inclined at 45° to the sighting line. The learner takes his sight through this glass in the usual way; the instructor watches the sights from the side, as they are seen reflected in the glass. Obviously, the instructor must possess considerable skill in order to use this appliance with advantage.

The aiming disc is a perforated metal disc which is placed in the observer's eye like a monocle. The learner aims at the perforation, and any *considerable* motion of the rifle during trigger-pressing can be seen by the observer. This appliance can only be used with advantage at short distances from the learner, and anyone accustomed to the use of fire-arms can scarcely avoid an uncomfortable feeling on watching a gun that is pointed at his eye.

I have devised a simple appliance by means of which most (if not all) of the benefits usually derived

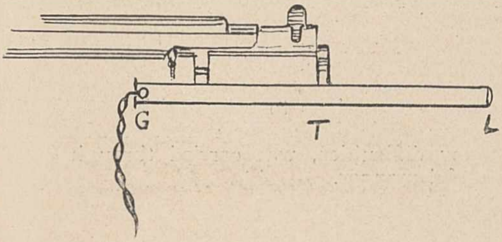


FIG. 5.

from a miniature range can be obtained without the use of ammunition. This appliance is represented diagrammatically in Fig. 5. A metal tube T, which can be fitted to the bayonet standards of a rifle, is provided with a lens L at the front end, and a small electric glow-lamp G at the rear end. The lens L can slide in or out, so that the image of the glowing filament of the lamp can be focussed on a white screen placed near the target. The current for the lamp can be supplied by three or four Leclanché cells; or a battery of dry cells, similar to that used for an electric torch, can be fixed to the tube T, thus obviating the inconvenience of the leads from the lamp to the cells. It is best to aim at a target about 10 yards away; an observer, who need possess no qualifications other than general intelligence and quickness of perception, stands or sits by the target and watches the image of the filament formed on the screen. I have obtained small electric glow-lamps which produce an image approximating in shape to a V. The position of the point of the V, at the instant when the trigger is pressed, can be marked on the screen; and if the rifle is moved during the act of trigger-pressing, the direction of motion, and its extent, can be marked by an arrow. If the position of the point of the V has previously been marked when the rifle was aimed by an expert, the correctness or otherwise of the learner's sighting is seen at a glance. I have found that most learners aim better than they shoot; that is, they sight the rifle on the bull's-eye with some approach to correctness, and then pull it away while they are actuating the trigger. If the learner is particularly bad at sighting, the rifle may be supported on a sand-bag or tripod stand, and sighting can be practised until a satisfactory "triangle of error" is obtained.

I have found, by the aid of the appliance just described, that different people can aim a rifle with perfect consistency according to the rules given earlier in this article. EDWIN EDSER.

THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE twentieth annual congress of the South-Eastern Union of Scientific Societies was held at Brighton on June 2–5, under the presidency of Dr. J. S. Haldane, F.R.S. The presidential address was entitled "The Place of Biology in Human Knowledge and Endeavour." Dr. Haldane gave to his hearers a deeper insight into the inexhaustible fulness of reality which science only partly explores, and puts us on our guard against the error of mistaking partial and abstract results for complete knowledge. He explained the marvellous nicety of the natural regulation of the act of breathing, and of the means by which constancy in the composition of the blood was maintained, and used these instances to prove the unwisdom of declaring ourselves to belong to either of the opposing schools of "mechanists" or "vitalists." In face of the evidences of "organic determination" which these instances gave, neither of these hypotheses could satisfy. In like manner, the partial character of even the highest conception of biology and of all science must be recognised, and recognising this, we should not be ready, merely because they are not susceptible of scientific treatment, to undervalue or ignore those higher elements of human experience which we designated moral and spiritual.

Incidentally, in noble and moving language, Dr. Haldane referred to the great struggle which is occupying all minds. "The flashes of war have lit up for us this spiritual world. The sense that it is our plighted duty to deal with an infamous disregard of elementary right has sent hundreds of thousands of our best and truest into the fighting line, and is marshalling the whole activities of our nation and its Allies in a manner in which they never were marshalled before. . . . Yet we are waging this war in the absolute determination to conquer, cost what it may. For we are fighting, not merely for our own advantage or safety, but for a higher duty; and the faith that this higher duty is a real one, and that in following it we are at one with that spiritual reality which is the only reality, gives us a resolution, a courage, and a confidence, which could come from no other source."

In a paper on the problem of terrestrial and fluviatile shellfish, Mr. Hugh Findon dealt with the genealogical history of genera of molluscs, tracing their ancestry by the aid of the geological record, and finding the ancestral habit at one time marine, and at another a fresh-water one. "As I read the geological evidence the history of the river mussels is exceedingly interesting. A line of marine mussels persisting from earliest ages until the present time gave off a branch which in Carboniferous times took to a fresh-water life, Anthracosa, and again in the Miocene period repeated the phenomenon in Dreissensia. The first branch, with the exception of Anthracosa, returned to the sea and gave rise to another persistent family, that of Trigonia. About half-way along this second line a branch was given off which also entered a fresh-water existence during the age of the Purbeck, and this time successfully, for the present age witnesses Unios flourishing as they never did before in the world's history. I have been unable to find any tendency to return a second time to a marine life in our living river mussels."

In speaking of the changes taking place in the Baltic Sea, Mr. Findon remarked that the sea was "becoming more shallow, and consequently the communication with the North Sea between the Danish Islands is less free than formerly. On the other hand, the drainage of the marshes of Petrograd has allowed more fresh-water to flow into it; thus there is less influx of salt-water at high tides, and the Baltic is becoming brackish. Indeed, the northern portion is almost fresh, and fluviatile shellfish have invaded the open water. Many well-known species of the sea-shore, on the other hand, have held their ground, and we have the phenomenon of salt-water species, such as mussels, cockles, and tellens with a periwinkle, *Littorina rudis*, the estuarine *Mya arenaria*, or gaper, and a small univalve, *Hydrobia balthica*, living in fellowship with the river mussel Unio, two pond snails, Limnæa and Bythinia, the fresh-water Neritina, and a small bivalve, Sphærium. The assemblage is a remarkable one, considering the normal habitat of each of these species, and thus in the Baltic to-day the Lamarckian theory of modification to, but not by, environment, is well illustrated by these marine species, which are gradually changing their salt-water habitat for a fresh-water one."

A paper was read by Mr. Edward A. Martin on Brighton's lost river, in which the gradual disappearance of this river, which at one time flowed out at the Steine Gap, was traced. The river must have been of some importance in prehistoric times, although in historical times its whole history is one of decadence and almost complete disappearance. From a consideration of other rivers on the south coast Mr. Martin endeavoured to build up a former condition of things, which enabled the old town of Brighthelmstone to be built on alluvial flats beneath the cliffs.

"When the Brighton river was in its prime, there is every reason to think that its action was the same as that which now characterises other rivers on the south coast. The flow of the water would bring down with it large quantities of sediment, and bars would be produced at its entrance into the sea. As these increased, alluvial flats would be formed. This, of course, was in pre-history. There were no harbour commissioners to remove the bar. Man had no interest in it. It may have been before his time in these parts. A delta was in process of formation, and would no doubt have been perfected, had not a rival power interfered. The formation of the Brighton delta was influenced at all times by the tidal rise, and this would have been increased on the forcing of the strait of Dover. The river acting in a north to south direction, and the tides acting in a west to east direction, brought about a combination of forces which caused the alluvial drift to move in a more or less easterly direction. There is every reason to believe that somewhere, a mile or more out at sea, the river was turned to the east by the tides, and that the river was bounded by an alluvial bank formed by the sediment brought down by the river, reinforced by the supply of gravel brought from the west, as it is now, by the tides. What has taken place at Shoreham, Newhaven, and Seaford, took place at Brighton, and I imagine that the Brighton river passed away towards the east below the cliffs for some distance, dropping its sediment on the way, before it was able to force and keep open its outlet into the sea. Lyell mentioned that in the reign of Elizabeth 'the town was situated on that tract where the Chain Pier now extends into the sea.'

"In the course of centuries the river became deprived of its excavating power, and many of its feeders were captured, so that the body of water flowing down became seriously lessened. The process was a slow one, but sooner or later the struggle with the tides proved an unequal one. Hitherto, all that the tides could do was to turn the river eastward and enclose it within a long, low-lying bank of shingle, and the denuding power of the wind and storm waves, raised on the shoulders of the tidal rise, was at a minimum. When the entrance of the considerable body of opposing water from the valley was modified, and the influence it possessed practically ceased, alluvium ceased to be deposited, and the denudation of the alluvial ground-covered flat and its destruction by the sea commenced. This went on unceasingly, until the whole of the land beneath the cliffs was washed away. Mantell remarks that 'the whole of the ancient town was situated on a spot now covered by the sands,' whilst Lyell mentions that 'the sea has merely resumed its position at the base of the cliffs, the site of the old town having been a beach which had for ages been abandoned by the ocean.' The old town had, as a matter of fact, been built on the alluvial flats which had been laid down by Brighton's lost river."

Discussion on the origin of the Brighton Rubble-Drift Formation in the Kemp Town cliffs elicited the fact that in addition to the palæolith from the raised beach (now at the British Museum), another implement of Chellean form has been obtained from the raised beach at Slindon, near Arundel, West Sussex.

Other papers read were by Prof. G. S. Boulger, on Kew: some notes on its connection with the history of botany; by Mr. A. Bonner, on the study of place-names; by Mr. A. W. Oke, on three Sussex worthies: Mantell, Robertson, and Jefferies; and by Mr. C. C Fagg, on regional surveys and local natural history societies. Excursions to points of interest in the district were made during the congress, which, in spite of many difficulties, was carried through in a very successful manner.

OSMOTIC PRESSURE AND THE PROPERTIES OF SOLUTIONS.

TWO monographs dealing with the properties of solutions have recently been issued by the Carnegie Institution of Washington. The first, entitled "Osmotic Pressure of Aqueous Solutions," is a report by H. N. Morse, on the investigations made in the chemical laboratory of the Johns Hopkins University during the years 1899–1913. This masterly investigation, extended already over a period of fifteen years, has been recognised at once, and universally, as one of the classics of scientific literature. As the substance of the investigation was originally issued in more than a score of papers, it is a great advantage to have the whole work summarised, corrected, and brought up to date by the author himself. The whole technique is now set out in a series of chapters dealing with the cells and manometer attachments; the manometers; the regulation of temperature; and the membranes. The fifth chapter contains a strong defence of the weight-normal system for solutions against criticisms and attacks that have been made upon it, arising mainly from the mistaken assumption that this method of working was the expression of some theoretical view of the nature of solutions or the mechanism of osmotic pressure.

The opinion is emphatically put forward that a comprehensive equation for the osmotic pressures of solutions can only be reached by means of experiments, and that so many phenomena are involved that it will be impossible to predict the osmotic pressure of a solution unless the magnitude of some of these, such as the hydration of the solute, have been determined by direct measurements made with the solution itself. Nevertheless, when the solutions are made up to equal weights of solvent instead of to equal volumes of solution, and when the volume used for calculation is the volume of the solvent used in making the solution, it has been found that the ratio of osmotic pressure to gas pressure falls to unity at 30° C. in a decinormal, and at 80° C. in a normal solution of cane-sugar. At lower temperatures, the ratio is greater than unity, probably on account of the formation of hydrates.

A similar remarkable agreement has been obtained in a final series of measurements, made under the most highly perfected experimental conditions, of the osmotic pressure of solutions of glucose at 30°, 40°, and 50° C. Twenty-four measurements are recorded, in which the average value of the ratio of osmotic pressure to gas pressure was exactly 1·000, and the average error less than ±0·001. In the case of mannitol at five or six concentrations, and at temperatures from 10° to 40°, the average ratio was $1{\cdot}000_5$, and the average error $\pm 0{\cdot}001_5$, showing that within the limits thus far investigated, aqueous solutions of mannitol obey the laws of Gay-Lussac and Boyle.

The volume concludes with a preliminary account of some experiments on the osmotic pressure of electrolytes, which do not appear to have been published hitherto in any of the scientific journals. Potassium chloride (half-normal), barium chloride, and potassium ferrocyanide caused a rapid degeneration of the membrane, probably due to the destruction of its colloidal character. The degeneration was progressive, and could not be remedied by long soaking in water. Lithium chloride rendered the membranes very sluggish, but they retained their semi-permeability up to a concentration of 0·6 normal; a solution of this concentration was observed over a period of one hundred days, the average osmotic pressure for the whole period being 18·789 atmospheres, and for successive groups of twenty days, 18·827, 18·894, 18·799, 18·636, and 18·405. The ratios of osmotic pressure to gas pressure at 30° were as follows:—

Concentration	0·1	0·2	0·3	0·4	0·5	0·6
Ratio	1·746	1·816	1·857	1·899	1·955	1·992

This *increase* in the ratio is entirely opposed to the effects produced by variations of electrolytic dissociation, but may be explained by the diminution of the free water as a result of the formation of hydrates.

This formation of hydrates in solution is a leading feature of the work described in the second monograph, by H. C. Jones and his collaborators. The first section of the monograph receives a separate title, "The Absorption Spectra of Solutions as Studied by Means of the Radiomicrometer," but its main subject is the influence of hydrated and non-hydrated salts on the absorption of light by water. The chief result is to show that aqueous solutions of hydrated salts generally have greater transparency than pure water at the centres of the absorption-bands. The exceptions are the 1 μ band for zinc nitrate and magnesium nitrate and the 1·25 band for magnesium nitrate. Non-hydrated salts, under similar conditions, give results in many respects exactly the opposite of those obtained with hydrated salts. The remainder of the monograph deals with "The Conductivities, Dissociations, and Viscosities of Solutions of Electrolytes in Aqueous, Non-aqueous, and Mixed Solvents." The chief solvents used were water, ethyl alcohol, ethyl alcohol and water, acetone and water, and ternary mixtures of glycerol, acetone, and water. The final chapter, covering nearly sixty pages, is devoted to a "Discussion of Evidence on the Solvate Theory of Solution obtained in the Laboratories of the Johns Hopkins University." This summary extends from the time when, as the author says, "In the summer of 1893 I went to Stockholm to work with Svante Arrhenius," and extends to the present day. It deals with the work which has appeared in eighty papers, widely scattered through chemical and physical literature, and published in American, German, French, and English scientific journals, in addition to nine monographs already published by the Carnegie Institution of Washington. It is to the support of this institution that the present wide extension of these investigations is largely due.

T. M. L.

ELECTRONS AND HEAT.[1]

WHEN electrified bodies are heated they are found to lose the power of retaining an electric charge. The charge leaks away from their surfaces. This is not a novel phenomenon. It has been known for nearly two centuries that solids glowing in air are capable of discharging an electroscope. Thus you observe that the electroscope is at once discharged when I bring near it a red-hot poker withdrawn from the furnace on the lecture table. These effects are due to the emission of ions by the hot solids. For example, if the electroscope is negatively charged it draws positive ions from the hot poker and so becomes discharged.

Most bodies when heated in air at low temperatures emit only positive ions. At sufficiently high temperatures ions of both signs are emitted simultaneously. We can show this by a simple experiment in which the hot body consists of a loop of platinum wire and acts as its own electroscope. When a charged rod is brought near the loop a charge of opposite sign is induced on the latter, which is thus deflected owing to the electrostatic attraction of the rod. When the loop is cold this happens whatever the sign of the charge on the rod. If the wire is at a dull red heat it can only be deflected by a positively charged rod. When a negatively charged rod is brought near it the emission of positive ions causes the induced positive charge at once to stream away. Thus the wire is incapable of retaining a positive charge, and so no deflection is produced by a negatively charged rod. At very high temperatures you observe that the loop is undeflected whatever the sign of the charge on the rod. The wire is now liberating both positive and negative ions, and so is unable to retain either a positive or a negative charge.

If these effects are investigated in a vacuum, instead of in air at atmospheric pressure, it is found that the emission of positive ions gradually disappears with continued heating, so that a wire which has been well glowed out in a vacuum emits only negative ions in appreciable quantity. Thus if we repeat the last experiment with an incandescent lamp, using one in which the filaments are not anchored, we see that the loops are attracted by a negatively charged rod, but not by one which is charged positively. They show, in fact, a behaviour which is precisely opposite to that of a wire at a dull red heat in air.

Now let us consider the nature of the ions which carry these thermionic currents, to use a term which I have ventured to apply to the currents which leak away from the surfaces of hot bodies in this manner. As is well known, the negative electrons which play such an important part in physical phenomena are very readily deflected by moderate magnetic fields, whereas ions of atomic or greater magnitude are not.

[1] Discourse delivered at the Royal Institution on Friday, May 7, by Prof. O. W. Richardson, F.R.S.

I have here an arrangement which will enable us to apply this test to the ions emitted by hot bodies. An exhausted tube carrying a horizontal hot wire is placed in a vertical electric field. The electric field is arranged so as to drag the negative ions emitted by the wire to a suitable electrode, whence they flow through a galvanometer, the deflection of which is registered by the spot on the screen. Around the tube an electromagnet is arranged, so that, when it is excited, there is a horizontal magnetic field which tends to curl up the paths of the ions. If I now switch on the electromagnet you observe that the current is at once reduced to a small value, showing that the magnetic field curls up the paths of the ions; so that they are now unable to reach the electrode. The carriers of this negative discharge are, in fact, electrons.

I have here a second tube arranged to give a conveniently large positive discharge. When this is tested by the electromagnet in a similar way, the magnetic field is found to have no influence on the thermionic current. The positive ions are, in fact, much more massive than the electrons; more elaborate experiments have shown that they are charged atoms.

We see from these experiments that the negative emission is characterised by the electronic nature of the carriers and by its permanence in a vacuum. The presence of a gaseous atmosphere is not necessary in order to maintain these currents. Thus the electrons must come from the heated body itself. I believe that this emission is a process which is closely analogous to evaporation. The essence of evaporation, of a liquid, for example, lies in this: that, as the temperature is raised, the molecules acquire sufficient energy to overcome the forces which attract them to the liquid, and so become free molecules of the vapour. We know that all material substances contain electrons, and it is not unreasonable to expect these to behave, when the temperature is high enough, in a way analogous to the molecules of a liquid. Another analogy, in some ways more accurate, would liken the emission of electrons to the reversible evolution of a gas by the decomposition of a solid such as calcium carbonate. The similarity of this process to evaporation is well known to chemists.

This position is strengthened when we examine the way in which the electron emission depends on the temperature of the hot body. This may readily be done by surrounding the hot wire with a cylindrical electrode to catch the electrons, which then flow through a galvanometer, the deflection of which measures their number. The hot wire is arranged to lie in one arm of a Wheatstone's bridge, so that its temperature may be deduced from its resistance. Innumerable experiments with different substances have shown that this emission increases with great rapidity as the temperature rises, just as does the corresponding phenomenon in the case of evaporation. The correspondence is, in fact, exceedingly close. We may take the rate of emission of molecules from the surface of an evaporating liquid to be proportional to the vapour pressure. The proportionality is not exact, but it is sufficiently so for our purpose. The crosses on the next slide represent values of the vapour pressure of water, on the vertical scale, plotted against the corresponding temperatures from 0° C. to 90° C., on the horizontal scale; whilst the circles represent the emission currents from platinum plotted similarly against temperature over the range 1000° C. to 1250° C. All the points lie on the same continuous curve within the limits of experimental error. To bring about this coincidence it is, of course, necessary to plot the temperatures on quite different scales in the two cases, but the agreement demonstrates in a simple way the similarity of the laws which govern the temperature variation in both cases.

Numerous cases of electron emission have now been examined, and it has invariably been found, provided there is no reason to suspect changes in the chemical nature of the emitting surface, that the relation between the current i and the absolute temperature T is expressed by a very simple equation. This is $i=AT^{\frac{1}{2}}e^{-b/T}$, or $\log i-\frac{1}{2}\log T=\log A-b/T$, where A and b are constant quantities for any particular substance. The theory underlying this equation shows that the quantity b is very nearly equal to twice the energy change, expressed in calories, when one gram-molecular weight of the electrons is emitted. Pursuing the analogy with evaporation, this quantity may be called the molecular latent heat of evaporation of the electrons. It is not, however, with the theory underlying this equation that I particularly wish to concern you now; but I do wish to impress the fact that this formula is not an empirical affair covering a small range of temperature and current. The most recent measurements, made with tungsten, have shown that the formula expresses the results within the limits of experimental error, over the range of temperature from 1050° K. to 2300° K. At the lowest temperatures the currents were less than one-millionth of a microampere per square centimetre, and had to be measured with a sensitive electrometer, whilst at the highest temperatures they were comparable with one ampere per square centimetre, and could be measured on a commercial ammeter. Thus the equation holds true, whilst one of the variables changes by the enormous factor of 10^{12}. There are not many physical laws which will stand so severe a test as this.

Let us now turn to some other consequences of the hypothesis that the emission of electrons is analogous to evaporation. One of the familiar effects of evaporation is to cool the liquid which gives off the vapour, owing to the latent heat of vaporisation. In an exactly analogous manner a wire which is giving off electrons will be cooled thereby. I think I can succeed in demonstrating this effect to you, although the lowering of temperature to be looked for is not very large, and delicate means have to be employed to detect it. This tube contains a hot tungsten wire which is made to act as its own thermometer by placing it in one arm of a sensitive Wheatstone's bridge. Minute changes in its resistance can thus be measured. The bridge is balanced with the electrode surrounding the hot wire negatively charged, so that the thermionic current does not flow. If I reverse the potential and thus start the thermionic current, keeping the heating current constant, you observe a sudden deflection of the spot of the bridge galvanometer. The direction of this deflection corresponds to a reduction of the resistance of the hot wire and thus to a lowering of its temperature. By experiments of this kind Prof. Cooke and I succeeded in measuring the latent heat of evaporation of the electrons directly.

Just as a liquid is cooled by evaporation so it is heated to a corresponding extent when the vapour condenses. In fact an elementary experiment with which every student of physics is familiar consists in measuring the latent heat of evaporation by blowing steam into water. A precisely analogous experiment can be made with electrons. A large electron current from a hot wire is driven on to a fine strip of the metal of which the latent heat of condensation for electrons is to be tested. The cold strip is made to act as its own thermometer by placing it in one arm of a sensitive Wheatstone bridge. When the hot wire is charged positively there is no electron current to the strip, and the bridge is balanced under these conditions. The wire is then charged negatively so as to make the electrons flow on to the strip. There is then an increase in resistance, due to the heat liberated by the condensation of the electrons, which is measured. In these experiments only part of the observed change of resistance arises from the effect under consideration. The remainder is caused by the kinetic energy given to the electrons by the auxiliary field used to drive them from the hot wire to the strip. This, however, is easily determined and allowed for.

I have now indicated to you three independent methods of deducing the values of the latent heat of emission of the electrons. Let us see how the latest and most accurate values obtained by these methods agree with one another. The numbers found, and the names of the experimenters responsible for them, are shown in the following table:—

Values of Latent Heat of Emission Reduced to Equivalent Temperatures.

(1) From the temperature variation of the rate of emission:—

Tungsten (Langmuir)...	$10{\cdot}5 \times 10^4$—$11{\cdot}1 \times 10^4$	calories per gram
,, (K. K. Smith)	$10{\cdot}94 \times 10^4$	,, ,,
Platinum (various) ...	12×10^4—16×10^4	,, ,,

(2) From cooling due to emission:—

Tungsten (Cooke and Richardson)	$11{\cdot}24 \times 10^4$	,, ,,
Tungsten (Lester) ...	$11{\cdot}04 \times 10^4$	,, ,,
Platinum (Wehnelt and Liebreich) ...	$13{\cdot}9 \times 10^4$—$14{\cdot}5 \times 10^4$	,, ,,

(3) From heating due to condensation:—

Platinum (Richardson and Cooke)	$13{\cdot}5 \times 10^4$	,, ,,

Unfortunately, the vacuum value for platinum given by the first method is still uncertain owing to complications caused by gaseous contaminants. Except for this the agreement between the different methods is very satisfactory.

We come now to the very interesting question of the velocity and kinetic energy which these electrons possess when they are emitted. The fact that they are electrically charged enables us to find out a great deal more about their emission velocities than we can do in the corresponding case of the emission of ordinary molecules. By applying an external electric field we can influence the motion of the emitted electrons, and the precise nature of the effect exerted by the field depends on the velocity with which the electrons are shot off from the hot body. It is clear that we have no such method of controlling the motion of ordinary molecules.

I shall now consider one of the arrangements which has been used in applying these principles to the analysis of the emission velocities. The hot emitting surface is a small strip of platinum, electrically heated, which lies at the centre of a much larger metal plate. The upper surfaces of the strip and the plate are flush with each other, and are maintained at the same potential. Vertically above this lower plate and a short distance away from it is a parallel metal plate connected to the insulated quadrants of an electrometer. An arrangement is provided by which a suitable difference of potential can be maintained between the two plates so as to *oppose* the motion of the electrons from the strip towards the upper plate. It is clear that if the electrons have no velocity when they are emitted, any retarding field, however small, will be sufficient to stop them from reaching the upper plate and charging up the electrometer. If, on the other hand, they are shot off with a definite component of velocity normal to the strip they will reach the upper plate, provided the corresponding kinetic energy exceeds the work they have to do to overcome the opposing difference of potential. Thus if the electrons are not at rest when they are emitted, they will give rise to currents capable of flowing *against* an applied electromotive force if this is not too large. I have here an arrangement, similar in principle to that just described, which will enable me to show to you the existence of these currents flowing against an applied electromotive force. The platinum strip is replaced by a very short tungsten filament, the upper plate by a surrounding cylinder, and the electrometer by a galvanometer. The apparatus is thus different in detail from that already referred to, but the principle is the same. You observe that the current is largest when the opposing difference of potential is zero, and falls off uniformly and rapidly as the potential difference is increased. By increasing the temperature I can cause a considerable current to flow against an opposing difference of potential of one volt.

The experiments just referred to are a kind of electrical analogue of the high jump, in which the measuring tape is replaced by a voltmeter. Corresponding to each emission velocity there is a definite equivalent voltage. The fact that the current falls off continuously as the opposing voltage increases shows that the electrons are not emitted with a single velocity but with different velocities extending over wide limits. Careful experiments of this kind have enabled us to discover what proportion of them are shot off with velocities within any stated limits, to determine, in fact, what is the law of distribution of velocity among the emitted electrons.

More than fifty years ago Maxwell concluded from rather abstruse theoretical considerations that the velocities of the molecules of a gas or vapour should not all be equal, but should be distributed in a certain way about the average value. This law, known as Maxwell's law of distribution of velocity, is somewhat similar to that which governs the density of bullet marks on a target at different distances from the bull's eye. The theoretical considerations which led Maxwell to establish this law for gases apply equally to the atmospheres of electrons outside hot bodies. Let us see whether the results of our experiments agree with Maxwell's predictions or not. If the law of distribution of the normal velocity component for the emitted electrons is that given by Maxwell, it is necessary (and sufficient) that the currents i_1 and i_2 which flow against potentials v_1 and v_2, respectively, should satisfy the equation—

$$\log i_1/i_2 = \frac{Q}{RT}(\nu_1 - \nu_2),$$

where R is the constant in the equation $pv = RT$ of a perfect gas, and Q is the quantity of electricity which liberates half a cubic centimetre of hydrogen at 0° C. and 760 mm. in a water voltameter. The requirements of this formula are found to be fully satisfied by the results of the experiments. Thus the logarithms of the ratios of the currents are found to be accurately proportional to the differences in the corresponding opposing potentials at a given temperature. Again, since Q is a well-known physical constant, and the value of T was estimated during the experiments, we can use the experimental data to obtain a value of the gas constant R. Eight experiments, made under conditions as varied as possible, when treated in this way, gave values of R which varied between the extreme limits $3{\cdot}08 \times 10^3$ and $4{\cdot}46 \times 10^3$ ergs per c.c. per degree C. These values exhibit a rather wide variation, which, however, is believed to be fortuitous; so that the mean value should be much more accurate. The mean of the eight values gives $R=3{\cdot}72\times10^3$, whereas the number given by the gas equation is $R=3{\cdot}711\times10^3$ in the same units.

The fact that the value of the gas constant can be deduced in this way from purely electrical measurements must be regarded as a remarkable confirmation of the general position. The results of these experiments, and of others of a similar nature which I have not time to describe, show not only that the velocities of the electrons are distributed about the average value in accordance with Maxwell's law, but also that the emitted electrons are kinetically identical with the molecules of a hypothetical gas of equal molecular weight at the temperature of the hot metal. The experiments referred to formed the first direct experimental demonstration of the truth of Maxwell's law of distribution of velocities, and, although many of the consequences of this law have been made visible by the beautiful experiments of Perrin on the Brownian movement, I believe that they still furnish the most direct experimental verification of its truth.

Quite recently a number of experimenters have called in question the general position which I have taken as to the nature of the process of electron emission from hot bodies, and have asserted that this effect is caused by chemical action between the hot solid and traces of contaminants, usually supposed to be gaseous, which have access to it. Whilst I feel that the value of the evidence in favour of the latter hypothesis has, generally speaking, been greatly over-estimated, it would take too long to discuss this question with the completeness which it demands. I shall therefore content myself with directing your attention to some experiments with tungsten filaments which prove that only an insignificant fraction, if any, of the emission from this substance can be attributed to chemical action.

Tungsten is peculiarly suited to these experiments on account of its great refractoriness. It can be heated in a vacuum for considerable periods at temperatures so high that all known impurities are volatilised out of it. The preliminary treatment of the experimental lamps furnishes some novel features which may prove of interest. The ductile tungsten filaments are electrically welded to the supporting leading wires in an atmosphere of hydrogen. After mounting, the lamps are exhausted in a vacuum furnace (with an external air pressure of about 1 cm.) at 550–600° C. for about twenty-four hours, until the evolution of gas becomes very small. A Gaede pump is used for the internal exhaust at first, and, later on, liquid air and charcoal in addition. In the final stages the tungsten is glowed at about 3000° absolute, and, for the best results, the anode is heated by subjecting it to an intense electron bombardment from the hot wire. The conditions as to freedom from gaseous contamination which have been attained in this way are far superior to those which result from any other method of treatment.

With lamps thus prepared I have carried out simultaneous measurements of the rate of emission of electrons on one hand, and either of the variation of the pressure of the gas present or of the rate of loss of matter by the filament on the other. Particular experiments have led to the following numbers:—

(1) For each molecule of gas given off the number of electrons emitted by the filament may be as high as 260,000,000.

(2) At each impact of a gas molecule with the filament 15,000 electrons would have to be emitted, and

(3) Each atom of tungsten which disappears from the filament would have to cause the emission of 984,000 electrons.

The magnitude of these numbers entirely precludes the possibility that chemical action plays any significant part in this emission. Again, the *mass* of the electrons lost by a filament may exceed the mass of tungsten lost in the same interval, proving that the emitted electrons are not furnished *at the expense of* the tungsten. They must therefore flow in from outside points of the circuit. Thus these experiments furnish a direct proof that the electric current in metals is carried by moving electrons. The mechanism of metallic conduction becomes more mysterious every day, but this, at any rate, is a fact which has to be reckoned with.

Perhaps I can drive these matters home to you more effectually by means of a simple experiment which shows that these electron currents from tungsten in high vacua are not minute affairs requiring elaborate apparatus for their detection, but, at high temperatures, are of such magnitude as to be worthy of the consideration of the practical electrician. I have here a tungsten lamp, containing a filament 14 mm. long and about 3 mils. in diameter, in series with an ammeter, a resistance, a battery, and a second ammeter. They are arranged in the order named, so that there is an ammeter at each end of the lamp. In addition there is a side line from the cylindrical electrode of the lamp which can be switched through either a millammeter or an electric bell to the positive end of the battery. There is no auxiliary voltage in this side line. When I turn the current on you observe that the ammeters read differently, showing that more current is flowing into the filament at one end than out of it at the other. The difference is, in fact, equal to the electron current which flows into the wire sideways, and is registered by the millammeter. Those of you who cannot see the instruments will, at any rate, hear the electric bell when I switch the electron current through it. With a lamp which was somewhat better designed for the purpose than the present one, I have recorded a current of 0·7 ampere at one end, 0·45 at the other, and 0·25 in the branch circuit. So far as my experience goes, the only limit to the size of these electron currents is that which is set by the magnitude of the current which fuses the filament, provided the requisite driving voltage is available.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. T. R. Wilson, F.R.S., University lecturer in experimental physics, has been elected to a fellowship in Sidney Sussex College for a period of five years.

Messrs. C. C. Bissett, of Emmanuel College; H. B. Cronshaw, of Gonville and Caius College; H. Ogden, of Emmanuel College; and E. P. Farrow, of Trinity College, research students of the University, have qualified for the degree by the presentation of theses, which have been approved, in chemistry, mineralogy, physics, and botany respectively.

The Harkness Scholarship in geology and palæontology has been awarded to Mr. W. H. Wilcockson, of Gonville and Caius College, and the Wiltshire prize in geology and mineralogy to Mr. D. B. Briggs, of Jesus College. The Frank Smart prize in botany has been awarded to Mr. E. J. Maskell, Emmanuel College, and that in zoology to Mr. L. T. Hogben, of Trinity College.

The following lecturers have been reappointed for five years from October 1, 1915:—Dr. Searle and Mr. C. T. R. Wilson, in experimental physics; Dr. Marr, in geology; Dr. Shore, in physiology; and Mr. J. H. Grace, in mathematics. Mr. C. Warburton has been reappointed demonstrator in medical entomology for a period of three years.

GLASGOW.—On June 21 the honorary degree of Doctor of Laws (LL.D.) was conferred upon Prof. G. B. Mathews, F.R.S., formerly fellow of St. John's College, Cambridge, and Dr. G. S. Middleton, president of the Association of Physicians of Great Britain and Ireland. Other doctorates conferred on the same day were:—Doctor of Philosophy (D.Phil.), H. A. Reyburn; and Doctors of Science in Public Health (D.Sc. Pub. Health), A. A. Jubb and P. L. Sutherland.

LONDON.—Sir Alfred Pearce Gould has been elected Vice-Chancellor in succession to Sir Wilmot Herringham. For several months past Sir Alfred has been acting Vice-Chancellor in view of Sir Wilmot's absence on active service.

The Senate, at its meeting on June 16, appointed Dr. W. H. Bragg, F.R.S., to the Quain chair of physics, tenable at University College, in succession to Prof. F. T. Trouton. Dr. Bragg is at present Cavendish professor of physics in the University of Leeds.

The D.Sc. degree in chemistry has been granted to Mr. H. V. A. Briscoe, Imperial College (Royal College of Science), and the D.Sc. degree in physics to Mr. Thomas Barratt, Imperial College (Royal College of Science) and East London College, and to Mr. A. E. Oxley, an external student.

OXFORD.—The School of Geography has announced courses of lectures and practical instruction to be given next term on the following subjects:—Central Europe, physical and economic; geographical distribution of man and of rural occupations; form and movements of the earth (Prof. Herbertson); geography of Britain (Mr. Beckit and Miss MacMunn); land forms (Mr. Beckit); meteorology (Mr. Kendrew); surveying (Mr. MacKenzie). Lectures will be given on general geology and the geology of India by Prof. Sollas, and on the historical geography of Great Britain by Mr. C. Grant Robertson.

The committee for anthropology announces lectures and informal instruction on physical anthropology, psychology, geographical distribution, prehistoric archæology and technology, social anthropology and philology. The lecturing staff includes Prof. A. Thomson, Mr. H. W. Blunt, Mr. H. Balfour, the Rector of Exeter College, Prof. J. L. Myres, Prof. Sollas, Mr. E. T. Leeds, Mr. E. F. Carritt, Mr. Griffith, Dr. Marett, Prof. Vinogradoff, Mr. C. Bailey, Prof. Macdonell, Mr. V. A. Smith, Mr. S. Langdon, Mr. P. Manning, Prof. Wright the Principal of Jesus College, Prof. J. A. Smith, and Mr. A. C. Madan. Special lectures for Sudan probationers will be given by Mr. H. Balfour and Dr. R. R. Marett.

MR. S. C. LAWS, principal of the Loughborough Technical Institute, has been appointed principal of the Wigan Mining and Technical College.

IN its issue for June 4 *Science* announces the following gifts to American universities. Dr. L. D. Waterman, of Indianapolis, professor emeritus in the Indiana University School of Medicine, has made a gift to Indiana University amounting to 20,000*l.*, subject to an annuity during his lifetime, on the condition that the University devotes an amount equal to the income from this gift, the entire proceeds to be used for scientific research. The conditions and gift have been accepted by the University. Mr. A. Bonnheim, of Sacramento, has given to the University of California an endowment of 6000*l.*, with provision for its subsequent increase to 32,000*l.*, the income to be devoted to the maintenance of scholarships. Another gift of 17,000*l.* has been made for the erection of dormitories at Cornell University. This gift comes from the same anonymous contributor of 50,000*l.* some time ago.

IN his last report to the Union Government of South Africa, the Secretary for Agriculture points out that the difficulty of procuring good men to fill the scientific and administrative posts in the Department, which has been commented on before, continues. Men of moderate attainments are plentiful and easy to obtain, but good men are more in request than ever. It also appears as if men who are really worth having, and therefore usually in a position to choose, prefer to work in universities and other learned institutions which are independent or semi-independent of Government control, or engage in business on their own account, rather than in Government Departments, as in the former they have more scope and freedom of action and have not to waste time by furnishing multitudes of returns and continually explaining and demonstrating the necessity for their existence. Seeing that the value of the Department to the country depends in the first instance entirely upon the quality of its professional and administrative officers, this is a very serious matter. Efforts are being made to overcome the difficulty of obtaining professional and technical officers by giving scholarships to likely young men to study at institutions abroad, at which they can get the best training obtainable in their particular subjects. The course of study is usually a four years' one, and a number of scholars have already returned and been drafted into the Department. It is considered that this is one of the best methods of obtaining officers for the Department, but it may not entirely suffice, and from time to time officers will have to be appointed from wherever they are obtainable, as at present.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, June 3.—Prof. E. B. Poulton, president, in the chair.—The Misses Katherine **Foot** and E. C. **Strobell**: The results of crossing two Hemipterous species, with reference to the inheritance of two exclusively male characters. This may be considered as a continuation of the paper published in the Society's Journal (zoology), xxxii. (1914), pp. 337–373, on crossing *Euschistus variolarius* with *E. servus*, and the inheritance of a spot on the genital segment, which was an exclusively male character in the former species. The newly-discovered male character now investigated is the length of the intromittent organ, and is tabulated in the paper. The results of the crossing were not in accordance with Mendelian ratios as regards F_1 individuals. The authors further show that male characters can be transmitted without the Y chromosome. H. W. **Monckton**: Note on the plant-association at the foot of the Boium Glacier, Norway. The Boium is one of the larger glaciers which descends from the great Jostedals snow-field. It flows down into a head-valley of the Fjaerlandsfjord, and the foot of the ice is 492 feet above the sea. The latitude is between 61° and 62°, that is a little north of the Shetlands. At the foot of the ice there is the usual desolate space with fresh moraine, and plants are gradually finding their way on to this ground. In places where the ice has advanced a little, plants may be found growing and flowering close to the glacier itself. Among the plants thus creeping on to the moraine were noticed a combination of mountain and valley forms: of mountain plants there were:—*Salix herbacea*, L., *Saxifraga stellaris*, L., and *Phyllodoce caerulea*, L.; and of forms of general distribution which one does not usually associate with glaciers there were *Alchemilla alpina*, L., *Trientalis europaea*, L., *Pirola minor*, L., *Pinguicula vulgaris*, L., *Phegopteris Dryopteris* L., *Lotus corniculatus*, L., *Sagina procumbens*, L., and a species of Epilobium.—Dr. Otto **Stapf**: The Dragon Tree of Tenerife. The author showed various illustrations of the celebrated tree at Orotava, and especially a drawing by Don Augustin Monteverde, dating from the earlier months of 1819, before the tree was partially destroyed by a gale on July 21, in that year. This drawing is the property of Dr. Perez, of Orotava, who had sent it to Kew for comparison with other illustrations. Dr. Stapf discussed the known history of the dragon tree of the Canaries and notices of it from early writers, referring *inter alia* to the resinous product known as "Dragon's Blood," formerly used as a pigment and in medicine, but now almost restricted to colouring varnishes.

Zoological Society, June 8.—Dr. S. F. Harmer, vice-president, in the chair.—G. **Jennison**: The "nest" made by a chimpanzee in the Belle Vue Zoological Gardens, Manchester.—R. I. **Pocock**: The feet, scent-glands, and other external characters of the Paradoxurine Viverrids, belonging to the genera Paradoxurus, Arctogalidia, Arctictis, and Nandinia. It is shown how these may be distinguished collectively from the Viverrine genera (Genetta, Viverra, etc.), and also how they may be differentiated from each other in the characters discussed.—Dr. A. Smith **Woodward**: The skull of an extinct mammal related to Æluropus, obtained from a cave at the ruby mines, Mogok, Upper Burma. The skull is described as the type of a new genus and species.—Miss K. M. **Parker**: The early development of the heart and anterior vessels in marsupials, with special reference to Perameles.—Lieut. R. **Broom**: Certain Triassic Stegocephalians. Restorations are given of the skulls of *Brachyops laticeps*, Owen, and *Bothriceps australis*, Huxley, which are regarded as forming, with *Batrachosuchus browni*, Broom, a distinct family, Brachyopidæ. *Bothriceps huxleyi*, Lydekker, is shown to differ from *Bothriceps australis* in the structure of the occiput, and in having numerous small teeth on the parasphenoid, pterygoids, and prevomers, and thus to belong to a very distinct new genus.

Geological Society, June 9.—Dr. A. Smith Woodward, president, in the chair.—R. H. **Rastall** and W. H. **Wilcockson**: The accessory minerals of the granitic rocks of the English Lake District. The rocks described are the granites of Skiddaw, Shap, and Eskdale, the microgranite of Threlkeld, and the granophyre of Buttermere and Ennerdale. The material was pounded in a mortar, washed and panned, and the concentrate separated in bromoform after the removal of the magnetic portion. The results showed a variation of accessory minerals between the different intrusions, but a similarity between parts of the same intrusion, although the minerals of apophyses are not always the same as those of the main mass. One remarkable result obtained is the rarity of magnetite and the prevalence of pyrrhotite, which was present in every sample examined. Attention was directed to the characteristics of the zircon-crystals, which lent no support to the occurrence of definite types in granite and gneissose rocks respectively. In parts of both the Skiddaw granite and the Threlkeld microgranite, anatase and brookite were found in abundance. Epidote is the characteristic mineral of the Ennerdale granophyre, while garnet is abundant at Threlkeld and Eskdale. The Eskdale granite also contains much tourmaline. The Shap granite is characterised by apatite and sphene. Descriptions of accessory minerals founded only on examination of rock-slices are inadequate and misleading.—F. P. **Mennell**: The rocks of the Lyd Valley, above Lydford (Dartmoor). A small area on the north-east of Dartmoor is chiefly considered, though some of the conclusions are applicable to nearly all that part of the moor which lies north of the portion mapped by the Geological Survey. In the neighbourhood of Lydford the alteration of the Carboniferous rocks within the metamorphic aureole surrounding the granite is described, and it is shown that they are consistently cordierite- and biotite-bearing. North of the altered limestone the type of alteration is different, and leads to the inference that the beds are distinct. The change is of more than local significance, as from this point all round the north of the moor there is no bed of any thickness containing cordierite, while chiastolite, white mica, and andalusite proper, are characteristic. Coarse andalusite-rock and altered shale, with remarkable skeleton-crystals of chiastolite, are described from the Nodden quarries, together with other types of hornfels. The beds occupying the northern part of the contact-zone belong to a definite series. There is evidence that the cover of the granite mass has a dome-like character, and that the same stratigraphical horizon is in contact with the granite all the way from Sourton to Drewsteignton. The granite of Brator is described. It is a biotite-bearing rock containing a little microcline, as well as orthoclase and oligoclase. It is rich in cordierite, recrystallised from sedimentary material absorbed into the magma.

Physical Society, June 11.—Dr. A. Russell, vice-president, in the chair.—E. A. **Griffiths** and E. **Griffiths**: The coefficient of expansion of sodium. The thermal expansion and increase in volume on liquefaction of sodium were determined by a method based on the following principle:—The difference in expansion of a volume of sodium and an equal volume of glass (or quartz) was measured by differential weighing under oil at various temperatures. A volume of about 250 c.c. of sodium was suspended from one arm of a short beam balance and a weighed glass bulb of equal displacement from the other arm. Sodium expands uniformly with the temperature up to its melting point. The value 0·000226 was deduced for the coefficient of expansion. In changing from the solid to the liquid state, an increase of 2·57 per cent. occurs in the volume.—T. **Smith**: Notes on the calculation of thin objectives. Lens systems which are symmetrical about an axis have in general six degrees of freedom for first-order aberrations. Thin systems have only three degrees of freedom, and in consequence of the limited range of glasses only two degrees of freedom are practically available. In achromatic combinations of two lenses these two degrees of freedom are controlled by the general shape as distinct from the total power of each lens. In general when two given conditions are satisfied the curvatures of the inner surfaces are not equal, so that a cemented combination of two lenses is not possible. Owing to the increased light transmitting powers it is often necessary to have only two glass air surfaces, and thus more than two component lenses are necessary. The effect of bending any thin system as a whole by increasing the curvature of each surface by the same amount is investigated, and it is shown that with two given kinds of glass a triple cemented lens can be formed satisfying two arbitrary aberration conditions. Illustrations are given of astronomical objectives of both double uncemented and triple cemented forms, and the glasses are determined for which a doublet can be cemented.—T. **Smith**: Tracing rays through an optical system. Trigonometrical formulæ have been used for tracing rays not lying entirely in one plane through optical systems, as these can readily be arranged in a form suitable for logarithmic calculation. When a calculating machine is available such computations can be carried out more expeditiously by using algebraic formulæ; in form these correspond with the expressions for paraxial rays, and a comparison of the numerical result is likely to suggest what alterations should be made when a general ray does not behave as desired. If the two points in which a general ray meets an axial plane are defined as conjugate points, all pairs of conjugate points on a ray are connected by the same relations as hold for object and image points for paraxial rays, and the theory for paraxial rays can be extended to rays in general by placing a suitable interpretation on magnification, etc. The definition of conjugate points can be extended to include rays lying in axial planes, in which case the one point marks the intersection of the ray with the radial focal line formed by rays passing through its conjugate.—H. R. **Nettleton**: The accuracy of the lens and drop method of measuring refractive index. A simple arrangement for comparing on an optical bench the refractive indices of liquids for monochromatic light by the lens and drop method is described. The accuracy and sensibility of the method are discussed. Attention is directed to the accuracy obtainable in measuring a small radius of curvature of a lens face in terms of the well-known refractive index of water, and in measuring the refractive index of the glass of a lens.

Royal Meteorological Society, June 16.—Prof. H. H. **Turner**: Discontinuities in meteorological phenomena. Meteorological history is divided into "chapters" averaging $6\frac{1}{4}$ years long, with abrupt changes (or "discontinuities," as the author calls them) between. The dates of change are apparently settled by the movement of the earth's axis. They oscillate about mean positions in a cycle of 40·5 years, which appears in Brückner's collected "cold winters" for 800 years; in Nile flood records for 1000 years; and in measures of Californian tree rings for 520 years. The chapters are alternately hot and cold, wet and dry, as shown by rainfall and temperature records at Greenwich, Padua, and Adelaide.—C. **Harding**: Battle weather in western Europe, nine months, August, 1914, to April, 1915. The author briefly described the weather conditions bordering on the battle area of the western front. At the commencement of the war generally bright and dry weather prevailed, with occasional short spells of rain, but from mid-October to the end of February rainy and rough weather continued with but little cessation. Taking widely distributed stations over the British Isles, it was shown that the rainfall for the nine months in the north and west was below the average, but in the south and south-east it greatly exceeded the normal. With the western Continental stations the rainfall for the same period was everywhere excessive. The author says:—"It is not suggested that in the recent wet weather the rainy conditions have been generated by gun-firing, but it seems quite possible that at times, when the conditions are favourable to rain, the rains have been augmented or accelerated by the concussion initiated over the battle-grounds."

DUBLIN.

Royal Irish Academy, June 14.—Sir John Ross of Bladensburg, vice-president, in the chair.—H. **Ryan** and Miss P. **O'Neill**: Studies in the diflavone group. II.—Derivatives of diflavanone. By the action of benzaldehyde on diacetoresorcinol four isomeric substances were obtained. Three of these were cis-trans stereoisomeric dihydroxydichalkones, and the fourth was a structural isomeride of the others. α-Dihydroxydichalkone in the presence of alcoholic hydrochloric acid condensed with benzaldehyde, anisaldehyde, and piperonal, to yield dibenzylidene, dianisylidene, and dipiperonylidene derivatives of diflavanone. It was also found that dibenzylidenediflavanone can be obtained directly from diacetoresorcinol by condensation with excess of benzaldehyde in the presence of alcoholic hydrochloric acid, and in the same way the authors obtained dipiperonylidenedimethylenedioxydiflavanone. The latter method was also found well suited for the preparation of analogous monoflavanone derivatives, and was applied to the preparation of the flavindogenides derived from gallacetophenonedimethylether on the one hand, and benzaldehyde, anisaldehyde and piperonal on the other.

PARIS.

Academy of Sciences, June 7.—M. Ed. Perrier in the chair.—A. **Lacroix**: Some remarkable contact metamorphic phenomena of Madagascar granite. A description of a new type of amphibole, termed imerinite, intermediate between the richterites and glaucophanes; petrographic examination proved the presence of monazite as well as other minerals. As the presence of the monazite appeared singular, several grams were isolated and analysed and proved to contain 1·05 per cent. of thoria, ceria, 39·51 per cent. oxides of lanthanum and didymium, 27·80 per cent. The thorium is unusually low.—G. **Bigourdan**: Equatorial observations of comets, minor planets, etc., made between 1880 and 1904.—Jules **Amar**: Functional re-education. A description of a new arthrodynamometer for measuring the values of the angular displacements of the limbs and absolute forces exerted by groups of muscles in the case of invalids recovering from wounds.—M. **Agnus**: The echo of the ball and shell. An explanation of the double detonation heard on the discharge of a rifle or gun.—Stanislas **Meunier**: The structure of the Kodai Canal meteorite (India); an example of cataclasis in meteoric irons.—P. **Maze**: The rôle of chlorophyll. The author regards the pigments in the higher plants as possessing a purely physical function, and considers the direct controlling action of chlorophyll on the assimilation of carbon dioxide as doubtful.—Em. **Bourquelot** and A. **Aubry**: A comparative study of the influence of acetic acid on the synthetising and hydrolysing properties of α-glucosidase (glucosidase from low yeast, air dried). This ferment is very sensitive to the poisonous action of acids. It is destroyed in liquids containing very small proportions of acetic acid, and the fact that the two properties of synthesis and hydrolysis disappear simultaneously under the influence of these quantities demonstrates that both properties belong to one and the same enzyme.

June 14.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The approximate calculation of the effect of climate on the velocity of increase of temperature with depth in the soil.—C. **Guichard**: The W congruences which belong to a complex of the second order. Case where the equation in S has a triple root.—Pierre **Delbet**: Pyoculture. Pus from a wound is suggested as the culture medium *in vitro*. It is concluded that if the general and local conditions are such that the patient cannot make headway against the micro-organisms, then the latter will multiply rapidly in the pus secreted. If, on the contrary, the conditions are favourable, then the pus will be a less suitable medium of growth than the ordinary media. These hypotheses have been confirmed experimentally, and details of the method of applying them in practice are given.—Ernest **Lebon**: A new table of divisors of numbers.—E. **Bompiani**: The linear element of hyper-surfaces.—Arnaud **Denjoy**: Derived numbers.—Thadée **Peczalski**: Researches on thermal conductivity. A description of a new arrangement for the determination of the thermal conductivity of lead.—B. **Bogitch**: The superficial deformations of steels tempered at moderate temperatures. A study of the corrugations produced on a surface of polished steel on cooling down suddenly from temperatures of 225° to 400° C.—Louis **Gentil**: The Middle and Upper Cretacian in western Haut Atlas, Morocco.—D. **Eginitis**: Recent earthquakes at Leucade and Ithaca.—H. **Colin**: The distribution of invertine in the tissues of the beetroot at different periods in its growth.—F. **Bordas**: The sanitation of the camps and battlefields. Residual heavy tar oil, freed from napththalene and phenol, mixed with sodium resinate, forms a stable emulsion with water. This mixture is suggested as specially suitable for preventive treatment against flies.—J. **Bergonié**: The vibrations caused by an electromagnet worked with alternating current in non-magnetic bodies.—Th. **Guilloz**: The electric needle for the detection of projectiles in the human body.

BOOKS RECEIVED.

First Course in Chemistry. By W. McPherson and W. E. Henderson. Pp. x+416. (Boston and London: Ginn and Co.) 5*s.* 6*d.*

Geographic Influences in Old Testament Masterpieces. By Prof. L. H. Wild. Pp. xiii+182. (Boston and London: Ginn and Co.) 4*s.* 6*d.*

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Vol. xiii. Edited by Dr. J. J. G. Brown and Dr. J. Ritchie. (Edinburgh: Oliver and Boyd.)

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ARISTOTELIAN SOCIETY, BRITISH PSYCHOLOGICAL SOCIETY, and the MIND ASSOCIATION, at 6.—Joint meeting. Mr. Bertrand Russell's Theory of Judgment: Prof. G. F. Stout.

MONDAY, JULY 5.

ARISTOTELIAN SOCIETY, BRITISH PSYCHOLOGICAL SOCIETY, and the MIND ASSOCIATION, at 4.—Joint meeting. The Import of Propositions: Miss Constance Jones, Dr. Bernard Bosanquet, and Dr. F. C. S. Schiller.

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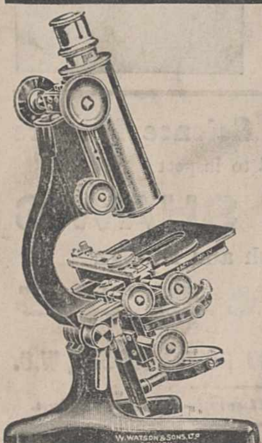

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