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

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THE SALVAGE OF NINETEENTH-CENTURY SCIENCE.

Theory of Functions of a Complex Variable. By Prof. A. R. Forsyth. Third edition. Pp. xxiv+855. (Cambridge: At the University Press, 1918.) Price 30*s*. net. (First edition, 1893, pp. xxii+682; second edition, 1900, pp. xxiv+782.)

TO anyone interested in the progress of British science the appearance of a third edition of this spacious volume, well-nigh two hundred pages longer than the first edition, must be a very welcome event. All those who know the conspicuous services which the author has rendered to mathematical learning will wish to congratulate him. And those who have known the stimulus of personal contact with him, who can recognise, beneath the happy diction with which the book is everywhere written, the sympathetic teacher, always able and willing to realise the learner's point of view, but eager to inform with a wealth of detail that is truly wonderful, will remember and be grateful. For the book stands between a time when, largely by the exigencies of a certain examination, a proof was soundest if it involved a considerable piece of algebra, and a time when the youngest student can prove anything by a judicious arrangement of arrow-heads. And the multiplicity of its content, who shall describe? Nor is it possible to say that it is too long if it be remarked that the index contains, for example, neither the entry "aggregate" nor the entry "enumerable."

It is easy, of course, for a reviewer, taking sections of the subject over which he happens to have pondered more intently than wisely, maybe, to explain how much better the book could have been, or to exemplify—what mathematical students do not usually know—the number of amendments necessary to the finished form of a mathematical theorem. And some indications may be given of how the present reviewer would discharge this traditional ungrateful duty if he were compelled to it. But they may be brief, and limited to the earlier parts of the book. As regards nomenclature, there was an opportunity for rendering the use of the words *analytic* and *monogenic* more uniform. The French use (Cauchy, Picard, Goursat, etc.) differs from the best German use. Compare Weierstrass's statement in regard to a construct ("Werke," iv., p. 13; or iii., p. 101): "und bezeichne dasselbe als ein monogenes weil es in seinem ganzen Umfange durch irgend eins seiner Elemente vollständig bestimmt ist." As regards uniform convergence there is some change in the present edition, the remarks on p. 92 (*cf.* the theorem, p. 156) differing from the statement on pp. 83, 84 of the second edition, and still more from those on p. 127 of the first edition, where the phrase "für jedes dem Bereiche angehörige Werthsystem" is untranslated. The difference between the case of a series of real functions and that of a series of functions of a complex variable might usefully be remarked. In regard to the definition of a function of a complex variable there is no substantial change; there is no reference to the question whether the derivatives of the function need be assumed continuous; and a holomorphic function is both monogenic and continuous. And in regard to the fundamental question of the integration of a function of the complex variable there still remains what is surely a very substantial incompleteness. If it be held that the curve of integration need not be rectifiable, and the continuity of the function need not be uniform, it should surely be so stated. As examples of complaints that may be put forward for later pages, we select only three. The statement on p. 248, that the integral can be made to assume *any* value, is incorrect. The proof on p. 245, for any three periods of a doubly periodic function, does not seem to carry Corollary II. without further amplification. The footnote on p. 344 might now be supplemented by reference to Painlevé, "Acta Math.," xxvii. (1903), and Camb. Phil. Proc., xii. (1903), p. 235.

But all this class of criticism seems impertinent to such a corpus of learning. There are two other reflections which are suggested by its perusal. When one turns over its brilliant pages and inquires of the history, one has sorrowfully to confess that not any substantial or path-breaking development has been made by British thinkers. All this illuminating theory, so important for the history of human thought, we owe to Frenchmen or Germans, or others. The great names are Cauchy, Abel, Riemann, Weierstrass, and Poincaré. It is a very interesting question: Why is this so? In the second place, nearly all this matter is the work of the nineteenth century. When the present war shall finally cease, how long will it be before mankind will be able again to turn from the inevitable necessity for the production of commodities to putting together such another body of clarifying thought? Well indeed is it that such a summary as this volume constitutes has been made, and very grateful should we be to the author—for such work remains among the imperishable records of human endeavour, a real joy for ever—but will a similar, or even a more productive, salvage be possible in 2018?

A TEXT-BOOK OF PLANT PHYSIOLOGY.

Plant Physiology. By Prof. V. I. Palladin. Authorised English edition. Edited by Prof. B. E. Livingston. Pp. xxv+320. (Philadelphia: P. Blakiston's Son and Co., 1918.) Price 3 dollars net.

IT has been a matter for surprise to those who were familiar, through the German edition, with Prof. Palladin's text-book of plant physiology that it had not hitherto been available in English. The German edition, which was based on the sixth Russian edition, appeared in 1911, so that we have had to wait unduly long for the present translation, which appears under the editorship of Prof. Livingston, of the Johns Hopkins University. The present work is based on the German edition, but it has been collated with the seventh Russian edition, which appeared in 1914, and any alterations have been included in the English text. Hitherto there has been available to students no text-book of plant physiology of small compass which could serve as an introduction to the larger works of Pfeffer and Jost. This book admirably fills the gap.

On p. 2 of the Introduction we find a list of the heats of combustion of hydrogen, carbon, starch, glucose, etc., and on p. 3 a discussion of the catalytic action of enzymes. It is thus clear from the outset that the author views the plant from the physico-chemical point of view, and keeps well to the front the dynamical aspects of the chemical processes occurring. Associated with this we find that—in the words of the editor—"Palladin's writing is more free from teleological misinterpretation of the relation between conditions and results than is that in most of the text-books hitherto available." The book may thus safely be put into the hands of students without the risk of the acquirement of a slovenly and unprogressive habit of thought.

The editor has provided footnotes—the authorship of which is clearly indicated—where the matter required bringing up to date or the author's treatment of a subject seemed to require elucidation or correction. These additions very greatly increase the value of the book, and many of them, as readers of Prof. Livingston's papers might expect, are models of what critical notes should be. These notes are most numerous in connection with photosynthesis, osmotic pressure, and water movement.

The book naturally brings to the front the work of Russian botanists, and renders available some results which the barrier of language has hitherto kept almost unknown. The treatment of fermentation and respiration, subjects to which valuable contributions have been made by Palladin and his pupils, is particularly good, but Kidd's work on the effect of carbon dioxide on both aerobic and anaerobic respiration should have been noted. The relation of oxygen to fermentation by yeast, which is imperfectly or erroneously treated in most text-books, is well brought out, though reference might have been made to the work of Horace Brown on the "occlusion" of oxygen by yeast-cells. Readers will be particularly glad to have an account of Palladin's work on the respiration of dead plants and of his chromogen theory of respiration. In dealing with transpiration both the part played by the stomata and the physical factors controlling the rate of diffusion of water-vapour from the plant might have been dealt with more fully. Mention might also have been made of the fact that both Gaidukov's observations on the reaction of Oscillaria to light of different colours, and those of Czapek on the relation of homogentisic acid to geotropic response, have been called in question. The treatment of growth, movement, and reproduction in part ii. is very much slighter than that of metabolism, and the subject of heredity is not dealt with at all.

All the citations of literature have been verified and the form of reference has been rendered uniform; special attention has also been paid to the transliteration of Russian names. Botanists will be interested to learn that, on his own authority, the author's name should be pronounced "Pallad'-din." V. H. B.

FUNDAMENTAL PRINCIPLES OF CHEMISTRY.

Stoichiometry. By Prof. S. Young. Second edition. Pp. xiv+363. (London: Longmans, Green, and Co., 1918.) Price 12*s*. 6*d*. net.

AS was explained in the notice which appeared on the issue of the first edition (NATURE, vol. lxxviii., 1908, p. 98), this book, which forms one of the well-known series of text-books of physical chemistry edited by the late Sir William Ramsay, deals with the fundamental principles of chemistry.

The present notice is devoted primarily to a consideration of the new matter which has been introduced into the book in order to give some account of the results arising from the numerous investigations carried on during the last decade. Of these results, none, perhaps, have had a greater influence on our fundamental conceptions than those which have been arrived at as a consequence of the investigation of radio-active substances. We have become familiar with the idea of non-separable, or isotopic, elements, which may, or may not, have the same atomic weight. Prof. Young adopts the recommendations of Paneth as giving, perhaps, the best definition of the term "element"; according to this suggestion, isotopes are to be regarded, not as different elements, but as varieties of the same element, so that an "element" may be pure or mixed according to whether it contains only one kind of atom or different varieties of isotopic atoms. The recent determinations of the atomic weight of lead derived from different sources, which have a bearing on the same subject, are referred to, while in the chapter dealing with the periodic law, after explaining the modern conception of an atom, the author gives a short *résumé* of the conclusions drawn by Soddy, Russell, and Fajans regarding the positions taken up in the periodic table by the products of the disintegration of atoms. No reference is made in this chapter to the difficulty which has been experienced in including the rare earth elements in the table, while a still more surprising omission is the absence of any allusion to the exceedingly valuable work of Moseley on the X-ray spectra of the elements, which has provided us with a method for the determination of atomic numbers and has led to results of the highest importance.

The numerous investigations relating to osmotic pressure which have been carried on in England

and America are described and discussed, while the section dealing with adsorption has been extended so as to include an account of recent work in this field.

A description is also given of several new practical methods. Amongst these may be mentioned Morgan's method for determining the molecular weights of liquids from the weight of falling drops, and the methods suggested by Smith and Menzies for the determination of the boiling points and vapour pressures of substances.

From the examples which have been given, it will be evident that, with one or two exceptions, the book has been brought thoroughly up to date, and can be confidently recommended to anyone desirous of having a clear and comprehensive account of modern views relating to such subjects as the properties of atoms and molecules, and the general properties of gases, liquids, and solids.

J. K. W.

OPTICS IN EUCLID'S TIME.

L'Ottica di Euclide. By Prof. G. Ovio. ("Manuali Hoepli.") Pp. xx+415. (Milano: Ulrico Hoepli, 1918.) Price 7.50 lire.

IT need scarcely be pointed out here that the greater portion of what we now call "optics," dealing as it does with applications of the laws of refraction, was unknown in the days of the Greek geometer. In this small volume Prof. Giuseppe Ovio, of Genoa, has condensed an exposition of the contents of two volumes known as "Optics" and "Catoptrics," of which the first is believed certainly to be due to Euclid, while his authorship of the second is regarded as rather more doubtful. In preparing this book Prof. Ovio has mainly based his work on the editions of Pena, Danti, and Heiberg, but has also consulted those of Gregory, Zamberto, and Freart.

"Optics Properly So-called," which forms the title of the first portion, is practically equivalent to our perspective geometry. It deals with the apparent dimensions of objects seen at different distances and in different directions. It thus consists of a collection of propositions really purely geometrical in character. For example, one proposition proves that an eye situated near a sphere sees less of it than one further off, but the visible portion appears larger. There are some theorems, on the other hand, of which the purport and meaning are rather vague, and Prof. Ovio's comments on these will be found useful. "Catoptrics" deals with reflection at curved surfaces. The propositions include proofs that a plane mirror produces an inverted image of the same size as the object, that rays after reflection at a concave surface sometimes converge and at other times diverge, and a large number of other properties, of which these may be regarded as typical representatives. According to Euclid, visual rays emanated from the eye and went to the objects.

Now that the younger generation no longer acquires its geometrical ideas from Euclid's elements, an interesting variation on our over-stereotyped school curricula might very well be introduced by occasionally teaching the subject-matter of this volume. Many of the proofs afford quite interesting lessons in deductive methods, and could very well be accompanied by excellent exercises in constructive geometry. But, unfortunately, the subject in its present form does not fall within the syllabus of school examinations.

G. H. B.

OUR BOOKSHELF.

Descriptive Catalogue of the British Scientific Products Exhibition, with Articles on Recent Developments. Pp. xxiv+268. (London, 199 Piccadilly: British Science Guild, 1918.) Price 2*s.* 6*d.* net.

THE record of industrial achievement during the period of the war shown at the recent British Scientific Products Exhibition organised by the British Science Guild was much enhanced by the publication of a comprehensive descriptive catalogue. Whilst the contained details of the exhibits and their technical applications added interest to their examination and form a valuable record for reference, the inclusion of a series of articles on recent industrial developments should do much to drive home and explain what has been accomplished during the past four years by the successful co-operation of science and industry, and what is needed for that fuller and more permanent effort which is required to secure industrial progress and efficiency. The story has been told in many forms, but every repetition that can extend an appreciation of the problem is to be welcomed. The catalogue of exhibits contains concrete examples of recent developments which form the basis for the story, and their direct association with a series of twenty concise and well-written articles by authorities whose names are a guarantee of first-hand knowledge provides a helpful correlation between the results obtained in works and laboratories and the objects and methods which have secured their realisation.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, and Papers in Elementary Engineering for Naval Cadetships, November, 1917, and March, 1918. Pp. 40. *Elementary Engineering Papers for Naval Cadetships (Special Entry) for the Years 1913–1917.* Pp. 33. Both edited by R. M. Milne. (London: Macmillan and Co., Ltd., 1918.) Price of each 1*s.* 3*d.* net.

A VOLUME of mathematical papers set to candidates for admission to the Military Academy and College was reviewed in a recent issue of NATURE. The first of the present publications is a further set of such papers. The other book contains the papers in elementary engineering set at recent examinations for Naval Cadetships. The questions in this collection cover the ground of the elementary theory of steam- and gas-engines, link motions, lathes, etc., and also presuppose some knowledge of the theory of hydrostatics, heat, and graphical statics. They are well devised and very clearly put to the candidates. The wording is often such as to act persuasively on the examinees. That the questions are also up to date is indicated by the presence of some on aeroplanes and kites.

Answers are given by the editor in the case of questions of a mathematical or arithmetical nature. There is a misprint on p. 11 of the "Mathematical Papers," line 6 from the bottom. S. B.

A Short Hand-book of Oil Analysis. By Dr. A. H. Gill. Revised eighth edition. Pp. 209. (Philadelphia and London: J. B. Lippincott Co., 1918.) Price 10*s.* 6*d.* net.

THIS is a handy little book for a student of oil chemistry to commence his technical practice with. It is intended as an introduction to larger works such as that of Lewkowitsch, and deals with the chief animal and vegetable oils, petroleum products, and the various greases used as lubricants. It gives the essential information briefly but clearly, and includes a good number of references to original sources of information. The volume is written from the American point of view, and some of the apparatus mentioned is more familiar in American laboratories than in this country. Some of the books quoted, also, are not readily accessible here. The British reader, however, will have no difficulty with the greater part of the work, and he will find it a very useful guide. The first paragraph on p. 175 wants revision: it appears to have suffered in the press.

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 Perception of Sound.

THE recent publication of Sir Thomas Wrightson's valuable and extensive investigations on the functions of the various parts of the auditory mechanism has brought into prominence a fundamental divergence of opinion as to the place where analysis of the complex sound vibrations occurs and as to the mode of vibration of the basilar membrane. The view of Helmholtz may be said to be that most generally accepted at present. As is well known, this theory states that the basilar membrane responds by resonance in different parts to the component waves of the complex, and that each of these components gives rise to its own sensation on arriving at the brain. The analysis takes place in the cochlea. Sir Thomas Wrightson's theory, which has received the powerful support of Prof. Keith, states that the basilar membrane as a whole follows in its wave form that of the complex, that the form of this complete compound wave is transferred to the nerve-fibres, and that no analysis takes place until the brain is reached.

Careful consideration of the evidence brought forward in support of this view has aroused several difficulties in my mind which, I venture to think, require explanation.

In the first place, there are certain physiological facts which make it extremely difficult to accept any sort of transmission of a complex wave form through a nerve-fibre. The work of Keith Lucas and his colleagues has shown that the process set going in a nerve-fibre has a definite time-course and magnitude, whatever be the way in which it is produced. If a sound-wave be enabled to stimulate a nerve-fibre by some appropriate receptor organ, the nerve process will be the same, however different the form of the wave. If this be true, it implies the necessity for a peripheral analysis, if there be any analysis at all. A similar difficulty arises in connection with the perception of notes of high pitch. If Sir Thomas Wrightson's theory is correct, the number of impulses passing along the nerve must be the same as the number of vibrations in the note, or possibly two or four times the number. The frog's nerve is incapable of responding to a second stimulus if it arrives less than 2/1000ths of a second after a previous one. It would, therefore, record all rates above 500 per second as identical. Doubtless this "refractory period" is shorter in the warm-blooded animal, but it is scarcely likely to be short enough to enable responses to 40,000 per second to be transmitted in their exact form.

It will be noticed by the physiological reader that Müller's law, which appears to have been first put forward by Sir Charles Bell, is involved here. It has been found that the sensation evoked from any nerve of special sense is identical, whatever the kind of stimulus applied. The peculiar quality of touch, taste, light, and so on, is due to the way the fibres end in the brain. Further than this in the way of explanation is at present impossible. But are we to suppose that the auditory nerve is the only exception to this law? What we should naturally expect would be that activity in one particular fibre, or, perhaps, set of fibres, in this nerve would be associated with the perception of one single definite tone, and that the form of the stimulus would be a matter of indifference. The theory of Helmholtz presents no obstacles in this respect.

In the second place, there is a physical question about which there seems some confusion. Many physiologists would be grateful to Lord Rayleigh if he would put us right here. There is no dispute as to the impression by the stapes on the liquid of the scala vestibuli of a series of impulses, corresponding in wave form with those air vibrations received by the membrana tympani. But, with the exception of the fact that the pressure is intensified, I am unable to see how these vibrations, when they arrive in the liquid, differ from those which would be present in the liquid if it were conducting sound in the ordinary way. It appears to be forgotten sometimes that liquids could not conduct sound unless they were both elastic and compressible. But the latter quality is, of course, extremely small, so that the amplitude of the vibrations is very minute. The actual movement in space of the column of liquid as a whole, contemplated by the Wrightson theory, is quite different, and, so far as I can see, the inertia of the mass would make it impossible for the force available to effect such movements at the rate of several thousand per second.

There is another point involved here which I confess to an inability to understand. When the stapes pushes in the membrane of the fenestra ovalis, the movement of the liquid shows itself simultaneously by a protrusion of the fenestra rotunda. Now the basilar membrane forms part of a partition between the two columns of liquid in the scala vestibuli and the scala tympani. If these columns were not connected at the apex of the cochlea, it is clear that the pushing in of the stapes must cause a bulging of the membrane into the scala tympani. It may be due to some oversight on my part, but I cannot see how there is a difference of pressure on the two sides when the column of liquid is a continuous one. This is a fundamental question in the Wrightson theory. It may further be pointed out that if the vibrations in the liquid to which the basilar membrane responds are the same as those of sound, there is naturally no difficulty with regard to hearing through the bone when the stapes has become fixed.

In the third place, objections made to the possibility of the basilar membrane acting as a series of resonators seem to me to have forgotten some facts pointed out by Helmholtz himself. The rate of vibration of a string is related, not only to its length, but also to its tension, and there is no reason why the range of the basilar membrane should not be increased by being more tightly stretched at its narrower end. So far from it being necessary to have a series of separate strings, Helmholtz demands only that a membrane of the shape of that of the basilar membrane should be more tightly stretched transversely than longitudinally, and in an appendix to the "Tonempfindungen" he gives a complete mathematical analysis of the vibration of such a membrane. I regret that this is beyond my mathematical capacity, but we may surely accept it. Prof. McKendrick has shown experimentally that resonance is possible in membranes immersed in water, as would be expected from theory.

On the other side, Held has stated that a single fibre of the cochlear nerve may supply a comparatively long stretch of the basilar membrane—undoubtedly a difficulty in the Helmholtz view. But the statement requires confirmation, and it must be a matter of great difficulty to decide it.

The explanation of the way in which the movements of the basilar membrane are altered in direction so as to stimulate the hair-cells is given very clearly by Sir Thomas Wrightson, and I have no objections to make to it. On the other hand, it is not clear why there are so many Corti arches and nerve-fibres present. One would have thought that a few would suffice to transmit the vibration if it occurs throughout the membrane at the same time and in the same form, no analysis taking place.

Sir Thomas Wrightson does not refer in his book to the interesting experiments of Yoshii, who found localised lesions in the organ of Corti as a result of prolonged exposure to a musical note.

Prof. Keith describes in great detail the minute structure of the organ of Corti, and states that various structures conform more to what is demanded by the Wrightson theory than to that of Helmholtz. I would demur somewhat to his view that every structure must have its function, although with deference to Prof. Keith's wide knowledge of the question.

It must be admitted that there are objections to be brought to both theories; but, on the whole, it seems to me that there are no vital ones to that of Helmholtz, whereas there are some to that of Sir Thomas Wrightson unless a satisfactory answer is forthcoming to those pointed out above. W. M. BAYLISS.

University College, London.

Rainbow Brightness.

IT would, I suppose, be very difficult to compute theoretically the brightness of any selected part of a rainbow in terms of the sun's actual brightness.

But it occurred to me that we might compute the relative brightnesses of two selected portions of the primary and the secondary bow, simultaneously presented and situated along a common radius. The luminosities would be due to the same sun, and to raindrops of practically the same size, so that any differences would arise from the fact that for the primary bow there is one internal reflection, but for the secondary there are two, and from the fact that the angular constants differ. This difference in the angles will affect both the polarisation and the intensities of the light reaching the eye, and will also increase the breadth of the secondary bow to about 1·61 of that of the primary, thus further reducing the brightness of the secondary.

But by restricting attention to portions of the red in each bow, situated along a common radius, I think we may leave out of account the influence of the increase in breadth.

Let P, S denote the brightnesses of the two portions selected (along a common radius) from the red of the primary and of the secondary bow. Then, using Fresnel's formulæ, with $\mu=4/3$, I get

$$P=\frac{k}{22\cdot40}, \quad S=\frac{k}{52\cdot20},$$

where k is an unknown factor. Thus $P/S=2\cdot33$ for the relative brightness of the red of the primary to that of the secondary, as viewed by the naked eye.

Now the light of both bows is very considerably polarised in the planes of reflection, which are radial and pass through the sun, the eye, and the element of arc observed. For the primary, 96·69 per cent. is polarised in, and only 3·31 per cent. polarised perpendicular to, the reflection plane. For the secondary, the corresponding quantities are 90·64 per cent. and 9·36 per cent.

Through a Nicol prism, placed first so as to transmit the "in" light, and next so as to transmit the "perpendicular" light, we get for the primary bow:

$$\frac{P\text{ (in)}}{P\text{ (perp.)}}=29\cdot20.$$

Similarly, for the secondary bow:

$$\frac{S\text{ (in)}}{S\text{ (perp.)}}=9\cdot69.$$

Thus for the two positions of the Nicol the primary bow is reduced about twenty-nine times, and the secondary nearly ten times.

I have often experimented on the primary bow, and the element of arc practically disappears for the second position of the Nicol. I hope to experiment similarly on an element of arc of the secondary bow, which, though losing a smaller fraction of its light, is originally fainter than the primary, and so may also be expected to disappear, though for the "perpendicular" azimuth of the Nicol the remnant left of the secondary bow is a trifle (1·21 times) brighter than that of the primary.

Finally, we can compare the brightnesses of the bows, first with the Nicol in, and next with the Nicol perpendicular to, the polarisation plane:

$$\frac{P\text{ (in)}}{S\text{ (in}}=2\cdot49,$$

so that the relative brightness with the Nicol slightly exceeds 2·33, that to the naked eye, when the Nicol transmits its maximum of each.

Next, $$\frac{P\text{ (perp.)}}{S\text{ (perp.)}}=0\cdot83,$$

so that the primary bow, as already stated, is slightly fainter than the secondary, when each is reduced by the Nicol to its minimum value. It would be of interest to test these cases by observation.

For the red light I gave 2·33 as the ratio of P to S for the naked eye. But to me the primary bow, viewed generally, appears brighter than this in comparison with the secondary. It is very difficult to make any true comparison on account of the varied colours. If we may assume that the secondary bow, owing to its greater breadth, is additionally weakened by the factor 1·61, we obtain $P/S=3{\cdot}75$ for a rough estimate of the relative brightness without restriction to any particular colour.

So far I have not met with any published estimates of the relative brightness of the bows or of the precise character of their polarisation, so that these figures may be of interest. CHAS. T. WHITMELL.

Invermay, Hyde Park, Leeds, October 4.

An "Arbor Day."

AT the meeting of the conference of delegates from provincial scientific societies to the British Association, held on July 4, a resolution was passed establishing October 21 as an "Arbor Day," and all the delegates present pledged themselves each to plant a tree if possible on that day, and to endeavour to induce members of all their societies and others to do the same. The time is now approaching for this to be carried into effect, and this letter is intended as a reminder.

By the wholesale cutting down of trees in this country during the last few years the scenery of our few woodland areas is losing its beauty, and we are greatly entrenching upon our very small reserve of timber. Although it is only by State action that the re-afforestation of our country can be adequately effected, it is hoped that by the carrying out of this resolution some little benefit may be derived, and that year by year our "Arbor Day" may remind us of the paramount necessity of augmenting our home supply of timber.

JOHN HOPKINSON.

Weetwood, Watford, October 14.

Students' Microscopes on Loan.

WE are conducting science classes on the lines of communication in France, and it has been suggested to us that some of your readers might care to loan students' microscopes for use in this work. If any who possess such instruments care to help us in this way, I shall be glad to hear from them. It will be understood that the instruments will be carefully kept and returned intact when finished with.

RICHARD WILSON,
The Librarian, Red Triangle Library.

Wimborne House, Arlington Street, S.W.1.

THE FUTURE OF THE COAL TRADE.

THE Coal Conservation Committee of the Ministry of Reconstruction has recently issued its final report, which forms, it need scarcely be said, a document of first-rate importance. Its form is decidedly curious, inasmuch as the report in itself is confined to a bare statement of the action taken by the Committee in appointing sub-committees, and the general adoption of the reports of these sub-committees, which are printed as appendices to the report; these reports are by the Power Generation and Transmission Sub-Committee, the Geological Sub-Committee, the Mining Sub-Committee, and the Carbonisation Sub-Committee. Of these the final report of the Mining Sub-Committee is undoubtedly the most interesting, and the most valuable in so far as it contains a number of recommendations of great technical and economic importance. Indeed, the reference to this sub-committee, which instructs it "to consider and advise what improvements can be effected in the present methods of mining coal with a view to prevent loss of coal in working and to minimise cost of production," covers a subject of most vital importance to the entire nation. British industrial supremacy is built up essentially upon a cheap and abundant coal supply, and whenever that supply becomes either less than sufficient for British industrial requirements, or more expensive than that of competing nations, Britain will cease to be a first-class Power. The safety and welfare of the nation thus depend so absolutely upon the coal supply that the recommendations of the Committee charged with its consideration assume a character of wide national interest.

The two principal subjects discussed are the loss and waste of coal and the cost of production. The former is subdivided into waste at the pit-head and loss underground. Waste at the pit-head is essentially confined to the excessive amount of coal used for colliery consumption. Relatively complete returns, representing 97 per cent. of the coal output of the country, have been obtained, so that tolerably trustworthy data are available, though it may be readily granted that the collieries that have failed to make returns are those at which the consumption is unduly high. The average colliery consumption for the kingdom is given as 6·8 per cent. of the output, or 18,400,000 tons of coal; in one of the other reports an estimate is given of the power employed in the mines and quarries of the United Kingdom, which is stated as 4000 million h.p.-hours. Taking this figure as due to the collieries alone, it would appear that our collieries consume no fewer than 10·3 lb. of coal per h.p.-hour, so that there is obviously room for much improvement. The report makes no reference to another source of waste, namely, the "free coal" which is allowed to coal-miners in some districts. Everyone who has had experience of these districts knows that the collier uses his free coal most extravagantly, and that quite considerable economies might be effected in this item without causing the slightest hardship, or even inconvenience, to the men concerned. Loss of coal underground is considered as arising from various causes, each of which is duly investigated.

The Committee considers that there has been a substantial improvement in respect of the small coal cast back into the goaf within the last ten years, and estimates the loss due to this cause as 0·91 per cent. of the output in 1915. It is obviously difficult to obtain accurate figures on this point, the collieries that are the worst offenders being, of course, those which furnish no returns, so that it is safe to say that the figures published by the Committee are below the actual wastage.

The only recommendation made is that a greater demand for small coal should be created—for example, by extending the market for briquettes. The present moment, when pitch is unusually cheap and the demand for household coal acute, is peculiarly suited to the generalisation of this convenient form of fuel, which has never come into public favour in this country, although it is deservedly popular on the Continent. This is surely a case where the Ministry of Reconstruction might do some real good if it would resort to deeds instead of mere words. Having regard to the scarcity of coal with which we are threatened during the coming winter, there is every reason why the Government should establish or assist in establishing briquetting plants in all centres where small coal is being wasted to-day, and thus usefully supplement the national coal resources.

An interesting and much-debated question is that of the loss of coal left in barriers underground; the Committee holds that a considerable proportion of barrier-coal might be worked if a central authority, such as a Ministry of Mines and Minerals, which the Committee wisely suggests should be created, had statutory authority to compel any barriers to be worked which could be worked safely, but it also points out that a large proportion of this barrier-coal could not be worked out without incurring risks which the Committee evidently finds to be unwarrantable. Under the head of coal left for support, the Committee discusses the effect of the well-known decision of the House of Lords in the Howley Park *v.* L. & N.W. Railway case (1912), and shows that it has operated adversely to the public interest, and is, moreover, probably opposed to the real intentions of the Legislature. The remedy proposed is that the prescribed distance within which a railway company has to pay compensation for coal left unwrought should be made to vary with the depth of the coal-seam, the distance suggested being equal to one-half of the depth of the seam beneath the surface. This would imply an angle of draw of $26\frac{1}{2}°$, whereas in practice a draw of 20° is about the maximum, so that most engineers will agree that the Committee has erred on the side of excessive caution.

On the question of wayleaves the Committee has merely repeated the conclusion of the 1883 Royalties Commission, to the effect that mineral owners unfairly debarred from a means of access ought not to be left without remedy. This conclusion has been inoperative for thirty-five years, and is likely to remain so; what is really required is something more definite and much stronger. At present wayleave rates are determined by the needs and means of those working the minerals, and not by the injury done to the landlord. What is really required is a statutory enactment that wayleaves shall in all cases be assessed by an independent tribunal, the measure of the payment to be made therefor being the damage suffered by the lessor granting the wayleave.

The all-important question of the cost of production receives but little assistance from the labours of the Committee; the very serious position is revealed that, whereas ten years ago the output of coal per worker employed was greater in this country than in Germany, to-day the reverse is the case, and the German miner is actually producing more coal per head than the miner in this country. The Committee is necessarily powerless in this matter, which depends essentially upon the coal-miner himself and his trade-unions, but the conclusion of the Committee on this subject deserves unqualified endorsement:—"It is only by increased production per head of the persons employed that our trade position can be maintained, and that improved conditions of employment can be secured, and this ought to be recognised by workmen as well as by employers."

One of the most interesting documents in the report is a letter from Mr. Robert Smillie, president of the Miners' Federation of Great Britain. The Committee strongly recommends the formation of a Ministry of Mines, a recommendation in which the majority of those interested in the mining industry will heartily agree; and Mr. Smillie wants not only such a Ministry, but further wants "the State to have the ownership and full control of the mines, not only on the productive side, but on the commercial side also." No doubt it would be a fine thing for a brief while for the coal-miners and their trade-unions if the State worked the collieries, and a compact and powerful body of voters like the coal-miners could no doubt dictate its own terms of employment; but this could not be except at the expense of the nation as a whole, and could last only until the increasing cost of coal involved the whole nation, and with it the miners and the mining industry, in universal ruin. The classical example of a State-worked coalfield is Saarbrücken, and everyone knows that the working of this field has cost the Prussian Treasury vast sums of money, operations having been carried on at a heavy loss, whilst the privately worked Westphalian coalfields made huge profits, and yet conditions of employment were better in the latter coalfield, and the price of coal to the general public was actually lower!

It is grossly unfair to suggest that British colliery proprietors have been unmindful of the safety of mine-workers. Every real improvement in the safety of coal-mining—*e.g.* the safety lamp, safety explosives, stone-dusting, prevention of gob-fires—has in every single case been due directly to researches undertaken at the instance, and paid for out of the pockets, of the colliery proprietors, whilst the State has done nothing at all. It is doubtful whether any one of these life-saving discoveries and inventions would be in existence to-day had collieries been worked by a red-tape Government Department instead of by enterprising individuals. Mr. Smillie does not suggest how the State is to obtain the ownership of the mining industry; he is far too shrewd to suppose that it could be done in any other than a perfectly equitable fashion, for he knows that our national credit, the most valuable asset we possess, is based essentially upon our reputation for fair dealing, and any action tending to tarnish even so slightly our fair name would be a serious national calamity. It is, however, very clear that the nation cannot afford to purchase and work the coal-mines of the country; our financial position to-day is not so strong that we can venture to take upon ourselves further burdens, particularly when there is nothing whatever to be gained thereby.

H. LOUIS.

SCIENTIFIC AND INDUSTRIAL RESEARCH.

ON July 23, 1915, a scheme for the organisation and development of scientific and industrial research was presented to Parliament by the Board of Education, and we now have before us the third annual report.[1] The scheme involved the formation of a Committee of the Privy Council with an Advisory Council composed of eminent scientific men and men actually engaged in industries dependent on scientific research. Of the first Advisory Council three valuable members, namely, Prof. Meldola, Mr. W. Duddell, and Prof. Bertram Hopkinson, have been removed by death, and their places have been taken by Sir Maurice Fitzmaurice, the Hon. Sir Charles Parsons, and Prof. Jocelyn F. Thorpe. We are reminded by this report of the great extent of the field which the Committee has under consideration, and Appendix IV. shows the constitution of various Boards and Committees of Research. Of these the first and most important is the Committee of the National Physical Laboratory, and the others are occupied with fuel, food investigation, industrial fatigue, tin and tungsten, while Committees have charge of questions relating to glass and optical design, mine-rescue apparatus, building materials, lubricants, copper and zinc, engineering in its various departments, and the chemistry of food and cooking. The establishment of a fuel research station is a matter of great national importance, and some questions relating to coal and coal-mining have already received preliminary consideration elsewhere. The large-scale experiments on coal-dust explosions initiated at Altofts some years ago have led to important results which will presumably be recognised by the Committee. The inquiry into the Irish peat question will also claim further consideration.

An interesting feature of the report is an account of the progress made in the establishment of industrial research associations of manufacturers under the Companies Acts, working without distribution of profits and limited by a nominal guarantee. Parliament has voted a sum of one million in aid of researches approved during the next five years, and the Department of Scientific and Industrial Research has already guaranteed to the British Scientific Instrument Research Association an expenditure of 36,000*l.* within that period. A grant of 1500*l.* a year has been assigned to the British Photographic Research Association, and a yearly contribution of pound for pound to the forthcoming British Cotton Industry Association has been promised. Similar terms are offered to the proposed British Research Association for the Woollen and Worsted Industry on condition that the subscriptions from the firms reach in each case an annual sum of at least 5000*l.* Altogether some thirty industries are already engaged in preliminary work for the establishment of research associations.

1 Report of the Commitee of the Privy Council for Scientific and Industrial Research for the Year 1917–18. (Cd. 9144.) (London: H.M. Stationery Office.) Price 4*d.* net.

The Iron Manufacturers' Research Association, founded by the British iron-puddlers, has set the good example of determining to investigate its own problems at its own expense, and by avoiding any claim on direct Government assistance in its finance it avoids that measure of regulation which is inseparable from the enjoyment of Parliamentary funds. It is not unlikely, and it is to be hoped, as the Advisory Council remarks in the report, that this example will be followed by other industries. Ultimately no doubt the great majority of research associations will become independent of direct State aid.

An important part of the work undertaken by the Advisory Council is the consideration of the problem how best to assist and encourage research workers and students. Grants have been made during the academic year 1917–18 to fifty-eight persons described as students, research assistants, or research workers, and the Council expresses satisfaction with the work done. It refrains from adopting any formal scheme until further experience has been gained, but in connection with provision for the future attention is again directed to the recently issued report[2] of Sir J. J. Thomson's Committee, and in particular to the fourth section, which deals with the supply of trained scientific workers for industrial and other purposes. The deficiency of recruits for the scientific professions and industries is so great that nothing short of far-reaching educational reform will provide a remedy. More time must be given to fundamental scientific subjects in the schools, especially the secondary and high schools; more help must be given to promising pupils, and attention may again be directed to the fact that there is nothing in scientific studies, theoretical or practical, which should deter girls from following such pursuits with a view to a professional career. But it must be understood that the pursuit of physical or natural science with practical ends in view is little, if any, less arduous than the training necessary for the medical profession. This, however, the last fifty years of experience have led women fully to recognise.

The report under notice is full of encouragement. British manufacturers are beginning seriously to believe in the association of science with industry, and we may look forward hopefully to the day when they will pursue their respective lines of research independently of the artificial stimulus derived from Governmental suggestion and support. In the meantime, it is to be hoped that pure science will not suffer neglect. The naturally inspired worker will generally be found to prefer freedom from official control, but he will continue to need in many cases precuniary assistance, which has been derived in the past from the several research funds administered by special societies. Among these the Government grant distributed by the Royal Society is the most important, but the meagre 4000*l.* a year for the whole circle of the sciences ought soon to be substantially increased.

2 See NATURE for April 18, 1918, p. 135

NOTES.

WE notice with much regret that among the victims of the sinking of the Irish mail-boat *Leinster*, which was torpedoed by a German submarine on October 10, was Sir W. H. Thompson, K.B.E., King's professor of Institutes of Medicine, Trinity College, Dublin, and scientific adviser to the Ministry of Food.

DR. RAYMOND PEARL has resigned his position of biologist of the Maine Agricultural Experiment Station, Orono, Maine, having been appointed professor of biometry and vital statistics in the school of hygiene and public health, Johns Hopkins University.

A BRANCH of the National Union of Scientific Workers was formally constituted at Liverpool at a meeting held at the University on October 10. The branch resolved to give general support to any schemes of federation of existing organisations of workers in science and technology, and decided on representation at the general meeting of the union.

PROF. W. A. BONE, with the concurrence of the authorities of the Imperial College of Science and Technology, has asked to be relieved of his duties as consultant to the Fuel Research Board on October 22, in order to be free during the coming winter to devote his attention to plans now under consideration for the post-war development of the department of chemical technology at the college.

THE American Academy of Medicine is offering a prize to be awarded in 1921 for an essay from a fund raised in honour of Dr. C. McIntire, who for the period of twenty-five years was secretary of the academy. The subject of the essay is, "What Effect has Child-labour on the Growth of the Body?" and the competition is open to all. The essays must reach the Secretary of the American Academy of Medicine by, at latest, January 1, 1921.

THE Tin and Tungsten Research Board of the Department of Scientific and Industrial Research invites proposals from firms and individuals in a position to undertake research work with the view of increasing the extraction of tin and tungsten from Cornish ores by the introduction of improved processes. Letters in connection with the announcement should be addressed to the Secretary of the Tin and Tungsten Research Board, 15 Great George Street, Westminster, S.W.1.

WE regret to note that the death of Mr. John Paul Wilson is announced in *Engineering* for October 11. Mr. Wilson was the late general manager of Palmer's Shipbuilding and Iron Co., Jarrow-on-Tyne, and was seventy-two years of age at the time of his death, which took place on October 4. He had a long and varied experience in shipbuilding on the Clyde, at Barrow, and on the Tyne, and for a time was shipbuilding director of the Anglo-Spanish yard at Bilbao, which yard he designed and laid out to build 7000-ton armoured cruisers in an unprecedentedly short time.

BY an Order of the Minister of Munitions, dated October 11, on and after October 21 no clinical thermometer can be sold which does not bear the approval mark of the National Physical Laboratory. Up to one month from the date of the Order the laboratory will approve thermometers which show no error exceeding 0·4° F. over the scale below 100° F., and after that date such as show no error exceeding 0·2° F. over that range. The charge for testing the thermometers will be 3*d*., and for a small additional charge a certificate giving details of the results of the test of an instrument will be issued.

SEVERAL letters have reached us referring to Lord Walsingham's suggestion (NATURE, September 5, p. 4) that species proposed in the German language should not be regarded as valid. We do not think any useful purpose would be served by a general discussion of this subject, or by anticipating the confusion in nomenclature which, Dr. W. E. Hoyle points out, would result in the future if it be carried into effect. In the interests of scientific system, Dr. Hoyle suggests that before it is acted upon the proposal should be submitted to the International Commission on Zoological Nomenclature, which was specially established to deal with such question.

THE death is announced, in his sixty-ninth year, of Dr. William Kent, who from 1903 to 1908 was Dean of the College of Applied Science at Syracuse University, U.S.A. From 1877 to 1879 Dr. Kent was editor of the *American Manufacturer and Iron World*, from 1895 to 1903 associate editor of *Engineering News*, and from 1910 to 1914 editor of *Industrial Engineering*. He was vice-president of the American Society of Mechanical Engineers from 1888 to 1890, and in 1905 was president of the American Society of Heating and Ventilating Engineers. His publications included "The Strength of Materials," "Strength of Wrought-iron and Chain Cables," and "The Mechanical Engineer's Pocket-book."

ACCORDING to the *Times*, news has reached Vardö that Capt. Roald Amundsen's Polar expedition in the *Maud* passed Yugor Strait on August 28 and entered the Kara Sea. As was anticipated from previous experience, September proved to be a good month for crossing the Kara Sea. The *Maud* met with no difficulties, and was last heard of by wireless telegraph from Dickson Island at the mouth of the River Yenisei, where she took on board a quantity of petrol and sailed eastward. The expedition has now left the last outpost of civilisation, and, unless news is received from wandering natives in the Taimir peninsula or around the Lena delta, nothing will be heard of the *Maud* for several years.

THE Commonwealth Government has now published the official report by Capt. J. K. Davis on the *Aurora* relief expedition to the Antarctic. It will be remembered that the *Aurora* was sent to the Ross Sea to rescue the ten members of the Shackleton expedition left at Cape Evans. The task was accomplished with Capt. Davis's usual skill in handling his ship in difficult ice conditions. Unfortunately, three members of the expedition had lost their lives during the previous winter—Capt. Mackintosh and Messrs. A. P. Spencer-Smith and V. G. Hayward. The *Aurora* left Port Chalmers, N.Z., on December 20, 1916, and returned to Wellington on February 9, 1917, thus making a record voyage to the Antarctic and back. The voyage was, on the whole, uneventful, and no new discoveries were made. A track-chart of the journey accompanies the report.

THE first of three Chadwick public lectures on "The Story of a New Disease" was delivered by Dr. F. G. Crookshank on October 10. The subject is the Heine-Medin disease or infantile paralysis, which may assume various forms. The recent cases of so-called botulism (see NATURE, vol. ci., pp. 170 and 209) are probably examples of a cerebral form of it. Dr. Crookshank reviewed the history of various mysterious outbreaks of sickness with nervous symptoms recorded since the fifteenth century, and suggested that the key to the understanding of these diverse nervous epidemics is to be found in the description by Willis in 1661 of an "epidemical feavour, chiefly infestous to the brain and nervous stock." This is to be considered in the next lecture on Thursday, October 17, at 5 p.m. (11 Chandos Street, W.1, admission free).

A COMMITTEE has been appointed by Mr. Walter Long to investigate the available sources of supply of alcohol, with particular reference to its manufacture from materials other than those which can be used for food purposes, the method and cost of such manufacture, and the manner in which alcohol should be used for power purposes. The members of the Committee are as follows:—Sir Boverton Redwood, Bart. (chairman); Major Aston Cooper-Key, C.B. (Home Office); Mr. Arnold Philip, Admiralty chemist (Admiralty); Mr. H. F. Carlill (Industrial Power and Transport Department, Board of Trade); Prof. C. Crowther (Board of Agriculture and Fisheries); Dr. J. H. Hinchcliff (Department of Agriculture and Technical Instruction, Ireland) (Irish Office); Sir Frederick Nathan (Ministry of Munitions); Mr. H. W. Garrod (Ministry of Reconstruction); Sir H. Frank Heath, K.C.B. (Scientific and Industrial Research Department); Sir Frederick W. Black, K.C.B.; Prof. Harold B. Dixon, F.R.S.; Brig.-Gen. Sir Capel Holden, K.C.B., F.R.S.; Dr. W. R. Ormandy; Mr. E. S. Shrapnell-Smith, C.B.E. (Deputy Director of Technical Investigations in H.M. Petroleum Executive); and Mr. Horace Wyatt (Imperial Motor Transport Council). Mr. Shrapnell-Smith will act as secretary to the Committee, and all communications should be addressed to him at the office of H.M. Petroleum Executive, 12 Berkeley Street, W.1.

WE regret to notice the announcement of the death in France of Lieut. P. M. Chadwick, R.E. Lieut. Chadwick was the son of Mr. and Mrs. Ellis Chadwick, of Parkstone, Dorset, and after a successful career at the City of London School and the Imperial College of Science and Technology, graduated B.Sc. in engineering. He then became in succession an articled pupil of Mr. Bailey Denton, assistant to the chief engineer of the new docks at Southampton, a lecturer at the City and Guilds Technical College, Finsbury, and finally a lecturer in civil engineering in Birmingham University. At Birmingham, under the direction of Prof. F. C. Lea, he made a critical examination of experimental data on the action of centrifugal pumps, and in a paper (published in *Engineering*) he attempted to express the results in the form of a characteristic equation. This work gained for him the James Forrest medal and the Miller prize of the Institution of Civil Engineers and the silver medal of the Birmingham Society of Engineers. He then proceeded to an original experimental investigation of the pressures in centrifugal pumps with the object of testing the theory, embodying the results in a thesis for which he was awarded the degree of M.Sc. in Birmingham University. At the outbreak of war he joined the Birmingham University O.T.C., and in 1915 was given a commission in the East Anglian Divisional Engineers. He saw service with the 54th Division in Gallipoli, and later in France.

THE Tokyo Society of Naval Architects has recently (July, 1918) published the second part of Mr. Shinji Nishimura's "Study of the Ancient Ships of Japan." It deals with the *Hisago-Bune* or "gourd ship." From a comparative study of Japanese and Korean myths and legends, and of the survival of the use of the gourd by certain women who fish for "ear-shells" on the coasts of Korea, Japan, and Chyoi-jyn Island, Mr. Nishimura arrives at the conclusion that in ancient times gourds were used as floats by swimmers and for rendering rafts buoyant. He insists upon the essential identity of these practices with the customs which still persist upon certain of the rivers of India and Mesopotamia, and suggests that the Japanese and Korean "gourd ship" is the Far Eastern modification of a device originally invented upon the banks of the Tigris and Euphrates. The influence of Indian and Egyptian methods of shipbuilding in eastern Asia has long been recognised; and it is of special interest to note that Babylonia has added a definite contribution to this easterly drift of sea-borne culture.

A "RADIOLOGICAL aeroplane" was described by Drs. Nemirowski and Tilmant before the Academy of Medicine of Paris at a meeting on September 3. It contains three places for the pilot, surgeon, and radiographer, and is provided with a generator for Röntgen-rays, one operating-table for operations performed with the aid of the rays, surgical instruments, and medicaments. The "Aerochir," as it is called, is intended to fly over the lines of action, ready to alight and render first aid to the wounded. The invention should be invaluable, provided, however, that it is not regarded by the enemy as a target for his fire.

IN continuation of his "Studies in Paleopathology," Prof. Roy L. Moodie cites numerous cases in which the condition known medically as opisthotonos appears to have set in at the time of death of fossil vertebrates (*American Naturalist*, vol. lii., p. 384, 1918). Some very familiar specimens, such as the Berlin Archæopteryx and the one complete example of Compsognathus, are included. The tetanic spasm has given "a peculiar curve to the backwardly bent neck" in these and other cases. The whole attitude of Osborn's *Struthiomimus altus* in the American Museum, including the contracted toes, provides a powerful example of this contention. The author urges that while some cases may merely represent the final struggle before the moment of death, others strongly suggest a cerebro-spinal or other intracranial infection.

IT is well known that the late Prof. Adam Sedgwick held somewhat unusual views with regard to what is commonly known as the "cell theory," and that these views were largely derived from his own investigation of the early development of *Peripatus capensis*. He maintained that in the young embryo the cell-boundaries were not properly defined—in fact, that the embryo formed a kind of syncytium with embedded nuclei. The precise knowledge which we already possessed of the segmentation of the egg and the formation of the germinal layers in other animals, even at the time he wrote, rendered it highly improbable that Peripatus formed an exception to the general rule; and Miss Edith H. Glen has rendered good service in demonstrating that Sedgwick's observations were inaccurate, and that, by appropriate methods, cell-boundaries can be demonstrated in the early embryo of *Peripatus capensis* as in other cases. Miss Glen's paper, published in the *Quarterly Journal of Microscopical Science* (vol. lxiii., part 2), also refutes Sedgwick's views as to the nature of the nephridia in Peripatus, and confirms the statement of Kennel that, as in the Annelids, they are of ectodermal origin.

IN vol. lxvii. of the *Archives Italiennes de Biologie* Major Gemelli, director of the psycho-physiological laboratory at Padua, gives an interesting account of the methods employed by the Italian authorities in the selection of aviators. As regards the psycho-

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logical aspect, these are more elaborate than those employed in this country. In addition to the determination of reflex times to visual, auditory, and cutaneous stimuli by the usual methods, a method is employed by which the subject must perform appropriate movements according to the nature of the stimulus given. Graphic records of "emotive reactions" are also taken by means of the pneumograph. In addition, the power of attention, judgment, and observation are tested. Results are also given of observations upon the pulse-rate, arterial pressure, and respiratory rate. These results are generally in accordance with those noted by other observers. As regards the pulse-rate, this is found to accelerate with increasing altitude, but to remain approximately constant while at a certain height. During descent there is at first a slight augmentation of rate, followed by a gradual diminution, but on landing there is always an increased rate compared with that at the beginning of the ascent. In regard to the arterial pressure, it is found during ascent that the systolic pressure first falls slightly and then rises, while the diastolic pressure gradually falls; during descent the systolic pressure falls, while the diastolic pressure again rises. After a flight there is always a hypotension. In rate, respiration follows the pulse, but to a less degree. The author has also made investigations in regard to the composition of the blood of aviators. He has observed an augmentation of the hæmoglobin index and of the number of red corpuscles in most pilots of long experience. As regards the rather vexed question as to whether this is due to a concentration of the blood or to the new formation of red corpuscles, the author inclines to the latter view.

AN abnormal change of air-temperature at Tokyo and Sinagawa on March 20 last is dealt with in the Journal of the Meteorological Society of Japan for August, 1918, by Kôsaku Sigetomi. At Tokyo the thermograph showed a rise of temperature amounting to 6·1° F. in twenty minutes, followed immediately by a sudden fall of 3·8° F. in the next ten minutes, and at the same time at Sinagawa, about $5\frac{1}{2}$ miles south of Tokyo, the air-temperature rose 14° F. in fifty minutes. Such an abrupt change of temperature in so short a time is said to be rare, and on December 19, 1912, the amplitude is said to have been 17·6° F. in about twenty minutes, but it is not noted whether the change was a rise or fall. A weather-chart is given for 2 a.m. March 20 to explain the change of temperature, and it is attributed to the presence of a cyclonic disturbance over the Japan Sea and to the passage of secondary disturbances in the south-western quadrant of the parent disturbance. A diagram is also given showing the records of the thermographs at several stations, with the wind directions at each hour, which shows very different results for stations in the north and in the south of Japan. The movements of cyclonic disturbances in Japan are similar to those followed in the British Isles, and subsidiary cyclonic disturbances are clearly subject to the same laws. In March the normal winds are northerly, with a high barometric pressure over Asia and a low pressure in the North Pacific. Charts for the period dealt with have not yet been received in this country, so that the details given cannot be easily followed or criticised. The occurrence is somewhat similar to the changes of temperature not unusually experienced in parts of the British Isles when a "V"-shaped depression or a line-squall is passing over the country.

ACCORDING to a Press dispatch from Amsterdam (quoted in *Engineering and Mining Journal*, August 10), the discovery that Germany does not hold a world-monopoly of potash comes as a great blow to those economists who thought that Germany could impose her own terms for the supply after the war. The Government has just presented a report to the Reichstag pointing out that Spain has unexpectedly entered the market as a large producer of potash, and urging the German mineowners to organise their forces to meet the new situation.

THE Austrian Treasury (according to a report in the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereines*, July 26) has decided to continue the investigations on a large scale into the occurrence of mineral oil and natural gas in Hungary, as the experiments recently made with the Eötvös torsion pendulum have given encouraging results. A large sum has been set aside for the work, which will be carried out by a number of geophysicists. The whole of Hungary will be systematically investigated from the point of view of the occurrence of mineral-oil deposits.

NEW regulations have been issued by the Physikalisch-Technische Reichsanstalt (*Elektrotechnische Zeitschrift*, July 4) regarding the testing of electrical meters. The complete outfit consists of transformers and one or more meters. During the testing of the instruments all auxiliary apparatus (power, current, voltage indicators, relays, etc.) that are to be actuated by the transformer in practice must be connected up or replaced by substitute resistances and coils with the correct energy consumption and power factor. If the secondary leads of a current transformer exceed 0·15 ohm, an equivalent resistance must be inserted during test.

CARL GOLDSCHMIDT discusses in *Technik und Wirtschaft* for August the question of the more thorough utilisation of the by-products of coal and lignite in gasworks, slow-combustion plants, extracting plants, etc. He points out that many of the valuable "key" products akin to naphtha are wholly or partially wasted in the processes at present in use. By proper thermal treatment of lignite in suitable plant and the subsequent careful treatment of the resultant products, it should be possible to secure even greater independence of foreign sources of supply of lubricants and of burning and lighting oils in the future.

La Nature of August 24 contains an interesting account of the recent discoveries in the so-called Lyons coalfield, which is, in effect, a concealed extension of the Saint Etienne coalfield on the left bank of the Rhone, south of Lyons. Whilst the first attempts to prove this area date back so far as 1855, it is only within the last few years that the existence of workable seams has been successfully demonstrated. The various borings are described in some detail in the original paper. The results show a long, narrow coalfield or, possibly, a string of small basins. The seams are narrow and the coal measures relatively deep, probably in some cases more than 2000 ft. below the surface. The coal is, however, a gas-coal of excellent quality, and the geographical position of the field, close to an important industrial centre like Lyons, is much in its favour. So far it is not supposed that the output is likely to exceed greatly one million tons per annum. There are, furthermore, indications that oil-shales may also exist in this field.

WE have received from the Board of Agriculture a copy of the Food Production Leaflet No. 53, which deals with the storage of sulphate of ammonia on farms. It is pointed out that, whether the sulphate is stored in bags or loose in a heap, the building in which it is kept should be dry and an efficient protection from rain. Sacks of sulphate of ammonia should be piled on a platform raised 6 in. from the floor, a 3-in. layer of some dry substance being placed beneath the platform to absorb any moisture draining from the sacks. The dry substance may be either castor-meal, rape-meal, bone-flour, or raw-bone meal (which can be afterwards used as fertilisers), but chalk, lime, or basic slag must not be used, as they would liberate ammonia from the sulphate. When the sulphate of ammonia is to be stored in a heap, the floor should first be covered to a depth of 6 in. with one of the absorbent substances mentioned above (failing these, a layer of dry soil, sand, or sawdust may be used). Before being applied to the land the sulphate should be freed from lumps, and may with advantage be passed through a ¼-in. riddle. This will not be necessary in the case of "neutral" sulphate (*i.e.* containing less than 0·025 per cent. of free acid), which contains no lumps and does not cake. Farmers are recommended to secure the neutral sulphate wherever possible, as this does not rot the bags, and can, moreover, be applied to the land through a drill.

THE re-awakening of interest in Canada in the shipbuilding and engineering industries some years ago came at an opportune time, in view of the world-war, and the various establishments organised are doing most useful service, both in the production of ships and in the supply of munitions. One of the leading establishments is that of the Canadian Vickers at Montreal, and these works form the subject of articles in *Engineering*, the first of which appeared in the issue for October 11. These works were started in 1910, and had attained full influence on the shipbuilding resources of Canada in 1915. The illustrations of the produce of the yard, which covers thirty-five acres, deal almost exclusively with merchant shipbuilding and high-speed motor-boats, of which a great fleet has been built. The company has also manufactured a large number of projectiles. The great floating dock, which forms such an interesting feature of the establishment, was roofed in so as to provide a workshop for the building of motor-boats, and thirty boats could be in progress simultaneously within the dock, while others were built in other departments on the shore. The transporting of the boats overland to a convenient Atlantic port was accomplished by loading them on exceptionally long and well-trussed trucks, with a four-wheeled bogie at each end, the bow and stern of the boat overhanging. It is not permitted, meanwhile, to enter into details of these boats.

BULLETIN No. 2 of the Department of Scientific and Industrial Research, which deals with cutting lubricants and cooling liquids, and with the skin diseases caused by lubricants, should prove very useful to engineers, although it contains no new work. The information comprised in the first part of the bulletin has been collected by Mr. T. C. Thomsen, who divides cutting lubricants and cooling liquids into the four classes: (1) Soluble oils which form an emulsion when mixed with water, (2) soluble compounds (or cutting compounds), *i.e.* greasy compounds which emulsify with water, (3) cutting emulsions formed by mixing either soluble oils or soluble compounds with water, and (4) cutting oils such as lard-oil, rape-oil, mineral oils, or a mixture of these. The principal uses of these classes of substances are: (*a*) Cooling, (*b*) lubrication, (*c*) to produce smooth finish, (*d*) to wash away chips, and (*e*) to protect from rust or corrosion. Efficient cooling of the tool edge reduces the wear and increases output; it is most apparent with high-speed steel. Lubrication is of little importance in cutting brittle material, but very important where the metal is tough. If cooling and lubrication are efficient, a good finish will result. To produce a perfect finish, cutting oils of great oiliness must be applied. The washing away of chips is frequently an important function, and if the cutting emulsion is too weak it will not be efficiently performed. The important factors to be considered in the selection of cutting lubricants are cutting speed and depth of cut, the material employed, the system of application, and the production of skin diseases. The latter are dealt with by Dr. J. C. Bridge, who describes them as of two kinds: (*a*) Plugging of the glands of the hair follicles, and (*b*) mechanical injury of the skin by metallic particles. The first sets up inflammation round the hair (folliculitis) and may lead to suppuration. For prevention of the diseases cleanliness of the worker and frequent cleaning of the lubricant and machines are recommended. The addition of antiseptics to the lubricant has not proved altogether satisfactory, but it has been suggested to sterilise the cutting oil by heat.

WHEN a beam, the weight of which can be neglected, has one end built into a wall and the other end loaded, the flexure of the beam is accompanied by a twist of successive sections with respect to each other unless these sections are symmetrical. The relation between the flexure and torsion has been worked out for beams of certain simple sections by Mr. A. W. Young, Miss E. M. Elderton, and Prof. K. Pearson in a Drapers' Company research memoir recently published. Some of the conclusions have been verified experimentally, and the authors hope that the research will serve as a first step towards the understanding of the relation between flexure and torsion in propeller-blades.

AN article in NATURE of April 18 (vol. ci., p. 138), describing contributions in the Journal of the Scottish Meteorological Society, referred to a chart called a climograph, devised to give a graphic representation of the various climatic conditions. It was stated that "the idea originated with Prof. Huntington," but we learn that this is incorrect. The method is due to Dr. Griffith Taylor, of the Meteorological Bureau, Melbourne, and Prof. Huntington acknowledged its origin and value in a lengthy review in the *Geographical Review* (New York) for November, 1917.

MESSRS. HENRY HOLT AND CO. (New York) give notice of a book by W. Beebe—entitled "Jungle Peace"—resulting from the author's experiences whilst in charge of the tropical research station of the New York Zoological Society in British Guiana. It will be illustrated from photographs.

OUR ASTRONOMICAL COLUMN.

LARGE METEORS.—Dr. F. J. Allen writes from Cambridge that he observed a brilliant meteor on September 27 at 10.7 pass rather slowly across the eastern meridian in a nearly horizontal S. to N. direction at an altitude of about 60°. Another fine meteor was seen from London, W., at 10.15 on the same evening. Mr. Denning observed from Bristol on October 4, 8.43, a large meteor, brighter than Venus, travelling slowly from the N. region of Pegasus into Cygnus. The same object was seen at Totteridge, N., by Mrs. Wilson, and it seems to have been rather low in the atmosphere, the height being from 42 to 31 miles, and the length of path 44 miles. The radiant point was at 13° – 10° near

η Ceti. Bright meteors were also recorded at Bristol, and their paths noted as follows:—

		h.	m.	mag.	°	°		°	°	
Sept.	30	7	43	= ♃	325	+10	to	325½	+4	slow
	30	7	46	1	348½	+30		29	+37	,,
Oct.	1	10	30	1	70	+37		72	+32	swift
	6	10	45	1	26	−9		33	−19	slow
	6	10	48	1	22	+42		22½	+49	,,
	8	8	4	= ♃	270	+73½		285	+78½	,,

Duplicate observations of any of these objects would be valuable in order to determine their real paths in the air.

OBSERVATIONS OF LONG-PERIOD VARIABLES.—The results of extensive observations of four long-period variables which have been made at Johannesburg are summarised by Mr. W. M. Worssell in Circular No. 42 of the Union Observatory. Formulæ for maxima and minima have been derived by including other available data, chiefly from observations at the Harvard College and Cape observatories. The names of the stars and formulæ for dates of maximum are as follows:—

R Horologii *025050*.
J.D. 2415220+400·4 E days; $M-m=174$ days.
RS Centauri *111661*
J.D. 2415024+164·2 E days + 14·5 sin (30 + 15 E)° days.
SV Scorpii *174135*
J.D. 2415259+258·4 E days; $M-m=148$ days.
RU Capricorni *202622*
J.D. 2415275+346·4 E days.

The numbers following the names of the stars give a rough indication of position; the hours and minutes of right ascension are indicated by the first two pairs of figures and the degrees of declination by the last pair.

CORRECTION OF APPARENT STELLAR MAGNITUDES.—In the Journal of the British Astronomical Association (vol. xxviii., p. 252) Mr. Felix de Roy directs attention to the importance of correcting estimates of stellar magnitude for atmospheric absorption. Tables are available which indicate the mean loss of light for an average star as a function of its zenith distance for a place of observation near sea-level. The mean absorption is under 0·05 mag. up to Z.D. 38°, reaches 0·1 at 47°, 0·2 at 58°, 0·3 at 64°, 0·4 at 69°, 0·5 at 72°, and then increases very quickly, reaching a whole magnitude at 80°, two magnitudes at 86°, and three magnitudes at 88°. With the aid of such a table, or a graph, it is easy to compute the apparent magnitude at a given time from the true (zenithal) magnitude as given in a catalogue. It is pointed out that the neglect of this correction may partly account for the discrepancies between individual estimates of the brightness of Nova Aquilæ during its brightest stages, as comparisons were necessarily made with stars at very different altitudes.

INTER-ALLIED CONFERENCE ON INTERNATIONAL SCIENTIFIC ORGANISATIONS.

THE following is a complete list of the delegates who attended the Inter-Allied Conference on International Scientific Organisations which was held at the Royal Society on October 9–11:—*British Delegates:* Sir Joseph Thomson, O.M., Sir Alfred Kempe, Prof. A. Schuster, Mr. W. B. Hardy, Prof. W. A. Herdman, Sir Frank Dyson, Mr. J. H. Jeans, Col. H. G. Lyons, Prof. C. S. Sherrington, Sir William Tilden, Sir Edward Sharpey Schafer, and Prof. J. A. McClelland. *Foreign Delegates.—Belgium:* M. Lecointe, Prof. Massart, and M. de la Vallée Poussin. *France:* M. B. Baillaud, M. G. Bigourdan, M. A. Haller, M. Lacroix, M. C. Lallemand, M. Moureu, and M. E. Picard. *Italy:* Prof. V. Volterra. *Japan:* Prof. Joji Sakurai and M. A. Tanakadate. *Serbia:* Prof. Bogdan Popovitch. *United States of America:* Dr. H. A. Bumstead, Col. J. J. Carty, Dr. W. F. Durand, Dr. S. Flexner, Prof. G. Hale, and Dr. A. A. Noyes. *Brazil:* M. Carlos de Carvalho.

The subjoined statement was adopted unanimously by the Inter-Allied Conference. It is intended to serve as a preamble to a number of resolutions dealing with the withdrawal of the Allied nations from existing international associations and the formation of new ones to take their place. The confirmation of the academies represented at the conference is required before the text of the resolutions can be made public:—

When more than four years ago the outbreak of war divided Europe into hostile camps, men of science were still able to hope that the conclusion of peace would join at once the broken threads, and that the present enemies might then once more be able to meet in friendly conference, uniting their efforts to advance the interests of science. For ever since the revival of learning in the Middle Ages the prosecution of knowledge has formed a bond strong enough to resist the strain of national antagonism. And this bond was strengthened during the latter part of last century, when branches of science developed requiring for their study the co-operation of all the civilised nations of the world. International associations and conferences rapidly multiplied, and the friendly intercourse between the learned representatives of different countries grew more intimate, in spite of their political differences, which were admitted but not insisted upon.

In former times war frequently interrupted the co-operation of individuals without destroying the mutual esteem based on the recognition of intellectual achievements; peace then soon effaced the scars of a strife that was ended. If to-day the representatives of the scientific academies of the Allied nations are forced to declare that they will not be able to resume personal relations in scientific matters with their enemies until the Central Powers can be re-admitted into the concert of civilised nations, they do so with a full sense of responsibility, and they feel bound to record the reasons which have led them to this decision.

Civilisation has imposed restrictions on the conduct of nations which are intended to serve the interests of humanity and to maintain a high standard of honour. Such are the recognition of the sanctity of treaties—especially those designed to apply to a state of war—and the avoidance of unnecessary cruelties inflicted on civilians In both these respects the Central Powers have broken the ordinances of civilisation, disregarding all conventions, and unbridling the worst passions which the ferocity of war engenders. War is necessarily full of cruelties; individual acts of barbarity cannot be avoided, and have to be borne. It is not of these we speak, but of the organised horrors encouraged and initiated from above with the sole object of terrorising unoffending communities. The wanton destruction of property, the murders and outrages on land and sea, the sinking of hospital ships, the insults and tortures inflicted on prisoners of war, have left a stain on the history of the guilty nations which cannot be removed by mere compensation of the material damage inflicted. In order to restore the confidence without which no scientific intercourse can be fruitful, the Central Powers must renounce the political methods which have led to the atrocities that have shocked the civilised world.

THE JOHANNESBURG MEETING OF THE SOUTH AFRICAN ASSOCIATION.

THE sixteenth annual session of the South African Association for the Advancement of Science was held in Johannesburg from July 8 to 13, with Dr. C. F. Juritz as president. There were receptions and functions of the type inseparable from such occasions, besides visits to municipal undertakings, to iron and steel works, to gold mines, to power stations, and to the Zoological Gardens. Of even greater interest to many of the visitors were the Union Observatory, the South African Institute of Medical Research, and the Water Board barrage on the Vaal River, the third largest in Africa, that of the Assouan Dam being the largest.

Nearly ninety papers were read at the various sections, and the attendance was larger than it has been for many years past.

Prof. J. T. Morrison, as president of Section A, discussed in its broad aspects the subject of the internal structure of the earth. The discussion proceeded mainly along geophysical lines, and it was suggested that it is the function of the geophysicist to investigate the processes by which have been maintained those incessant movements whereof the geological record is a witness, at the same time so indubitable and so perplexing.

The address of Dr. P. A. Wagner, president of Section B, had as its subject "The Mineral Industry of the Union of South Africa and its Future." He said that the recorded output of the Witwatersrand mines had exceeded a total value of 571,000,000*l.*, while for the single year 1916 the value reached was 38,492,000*l.* He estimated the gold still capable of being profitably recovered from the mines as worth 1,200,000,000*l.* The declared value of the country's diamonds had attained an aggregate figure of more than 216,000,000*l.* The coal industry was capable of considerable expansion, and the 1911 estimate, which placed the reserves at 56,000,000,000 tons, erred greatly on the conservative side. The dimensions of the country's future iron industry would depend on the rich titaniferous ores of the bushveld complex; of these more than 3,000,000,000 tons are computed to be available.

Mr. C. E. Legat, Chief Conservator of Forests of the Union, was president of Section C, and in his address dealt with the subject of the Union's forestry and timber supplies. There were, he said, two million acres of forest reserves in the Union, but only somewhat less than half a million acres of actual forest. When once the forests were in a normal condition—which would not be for a long time to come—the annual output of yellow wood would not exceed $1\frac{1}{4}$ million cubic ft.—a mere fraction of the Union's present requirements—and in fifty years' time these requirements would probably have doubled. Afforestation on a large scale is therefore essential; at least 300,000 acres of new coniferous plantations should be established, and 50,000 acres of hard woods.

In Section D the presidential office was filled by Dr. E. J. Goddard, professor of zoology in the University of Stellenbosch, and in Section E by the Rev. W. A. Norton, lecturer in Greek in the University of Cape Town. The latter urged the need of further research into things native, especially in comparative philology, language being the chief key to the psychology of a race, and psychology being necessary to their effective use, government, and education.

Dr. Thos. M. Forsyth, professor of philosophy in the Grey University College, Bloemfontein, in his presidential address to Section F, discussed the relations between philosophy and science. He aimed at showing that it is the endeavour of philosophy, no less than that of science, to avail itself of the experimental method. The philosophical significance of scientific units and standards of measurement lies in the truth that only in our sense-impressions have we direct experience of reality—the reality which science seeks to interpret. The way to the union of scientific and philosophic points of view lies accordingly in further elucidation of the nature of immediate experience, and the derivation thence of the conceptions by which experience is explained. The feeling of our oneness with Nature leads science to seek to reduce mind to terms of matter, and philosophy to reduce matter to terms of mind.

One cannot well do more than touch lightly here and there upon some of the salient points in the many papers which occupied the attention of the sectional meetings. In Section A a great deal of interest was aroused by Prof. Schwarz's audacious scheme for the conversion of the Kalahari into permanent pasture-land by building two weirs at the Cunene and Chobe rivers. The paper was discussed at great length and severely criticised by engineers, meteorologists, geologists, and botanists alike. Mr. J. A. Vaughan, in the course of a paper on safety in winding operations, said that the four hundred main winding plants regularly at work on the Rand made an aggregate of 31,000,000 trips per annum, while the winding accidents amounted to sixty-two—equal to a rate of one accident per half a million journeys. Dr. Moir gave the section a description of his method of fitting an equatorial sundial at small cost so as to introduce compensations for the irregular solar motion and enable one to read correct time.

In Section B Prof. Rindl made some additions to his paper of last year on the subject of South African medicinal springs. Amongst the springs newly described some striking features were exhibited by those of the South-West Protectorate, which are of deep-seated origin, and. apart from geysers, belong to the hottest springs known.

The Rev. Dr. F. C. Kolbe read a paper before Section C on the function of experiment in the teaching of botany in schools. The school-teaching of botany, he considered, might very well do all it can with direct observation, leaving the experimental stage to the university. Some of the experiments usually performed in schools are not logically valid, while others usually failed, and so did more harm than good. Dr. E. P. Phillips described a botanical collecting trip in the French Hoek district, and showed how the character of the vegetation changed from the strongly xerophytic types at the foot of the mountains as one rose to a height of 4000 ft. On attaining a height of 2000 ft. to 3000 ft. the trees are replaced by dense, tall bush, which, 500 ft. to 1000 ft. higher, is in turn succeeded by scrub. Miss A. M. King gave a description of what may prove to be a new species of Balansia growing on *Cynodon dactylon* about Pretoria. Dr. Ethel Doidge announced the appearance of Californian walnut blight in the South African walnut plantations, and described the characteristics of the disease (*Bacterium juglandis*). In another paper Dr. Doidge attributed the prevalence of bean blight (*Bacterium phaseoli*) to the exceptionally wet season in the Transvaal last summer. Miss A. M. Bottomley gave a preliminary account of a severe outbreak of fungoid disease which had begun to show itself among young cypress plants three years ago; and Mr. V. A. Putterill described the morphology and life-history of the fungus which causes "rust" in aloes. Mr. A. O. D. Mogg discussed veld-burning in its relation to stock-diseases. Veld changes resulting from burning may so alter the whole ration-selections of the grazing animals that they may commence browsing on widely differing plants, formerly avoided, and often of an inimical character.

In Section D, Dr. Annie Porter read a paper on the occurrence of leuctogregarines in South Africa; two such occurrences—one in a dog and one in a rabbit—had been observed. Prof. Fantham recorded the presence of various parasitic protozoa in South African fishes and amphibians; and Dr. F. G. Cawston gave an account of the cercariæ which attack South African snails.

The Rev. H. A. Junod described before Section E the customs of the Baronga in relation to smallpox. They had practised inoculation with the virus for many decades, using the serous fluid invariably from children or from old people, *i.e.* from those who might be called asexuate. The Hon. Mr. Justice Jackson read a paper on the medicine-man in Natal and Zululand. Unqualified men are allowed to practise on payment of a fee, and more than 1400 of these men have taken out licences. Dr. J. B. McCord also contributed a paper on Zulu witch-doctors and medicine-men, and described some startling surgical operations performed by these with no better instrument than a piece of broken glass. The Rev. J. R. L. Kingon spoke on unrealised factors in economic native development. He showed what profound changes had come about as a direct result of the use of certain implements, both of peace and war: the poisoned arrow and the assegai, the plough and the wagon, the primitive sledge contrasted with the railway, had each in turn exercised important effects in tribal life, and an axe had been the cause of a war. Mr. J. D. Marwick dealt with the important subject of the natives in the large towns. He uttered a warning regarding the growing tendency of the younger natives to form bands for the practice of crime and vice. Dr. C. T. Loram offered some practical suggestions for better provision for the medical needs of the natives; and two very interesting contributions were made by Mr. J. McLaren, one on Xosa arts and crafts, and the other on Xosa religious beliefs and superstitions. Of absorbing and unique interest was an account given by Dr. C. Pyper of the engraved (cup- and ring-marked) stones of the Lydenburg district in the North-Eastern Transvaal. Mr. W. Hammond Tooke discussed the problem of the Rhodesian ruins, and entered the lists against the views expressed on a former occasion by the Rev. S. S. Dornan. The latter gentleman also contributed a paper on the killing of the divine king in South Africa; the practice is founded on the belief that the potentate, in order to retain his divinity, must die a violent death as soon as senile decay sets in, lest the divine spirit should likewise suffer decay.

Before Section F, Mr. R. T. A. Innes initiated a discussion on the desirability of giving direct representation in the Upper House of the Union Legislature to education, agriculture, manufacture, mining, law, health, commerce, and finance. Purpose in education was discussed by Mr. H. C. Reeve; its ultimate aim should approximate towards the definite ideal of happiness for all. The demand for vocational training, so insistent of late, consequent on over-emphasising production, has revealed a lack of clear thinking, and the first need is, therefore, for leaders of thought to acquire definite views regarding education's ultimate aim.

On the first evening of the session, after the conclusion of the president's address in the Selborne Hall (see NATURE of September 19), Dr. Juritz presented to Mr. R. T. A. Innes, Union Astronomer, a cheque for 50*l.* and the South Africa medal annually awarded in recognition of achievement and promise in connection with scientific research in South Africa.

The 1919 session of the association will be held at Kingwilliamstown, with the Rev. Dr. W. Flint as president.

REPORT OF THE SURVEY OF INDIA.

THE report issued by Col. Sir S. G. Burrard, the Surveyor-General of India, for the year 1916–17 includes a most satisfactory record of work accomplished in spite of a depleted staff and the difficulties involved by war exigencies. It is gratifying to observe how this Department has responded to the call of the war; the list of honours awarded to its members for distinguished service in the field is one of which any department might well be proud. Survey detachments have been sent to Mesopotamia, Western Persia (with the Russian forces), Persia (generally), Salonika, Waziristan (with the Field Force), and to the Makran border mission. Not a word is said about the work accomplished by these military parties, but quite enough is known, independently of the report, to justify the statement that they have well maintained the reputation of Indian surveyors in the field of military action. We shall hear all about them in time, though probably not from India. The normal work of the Department has been well sustained, especially in the topographical branches, where good progress towards the completion of the 1915 scheme is recorded. Broadly, this scheme embraced a re-survey of India (of which the topography was then nearly complete, but much out of date) on the scale of 1 in. per mile, with a subsequent very wise reservation in favour of $\frac{1}{2}$ in. per mile for certain extensive but unimportant areas of wilderness and jungle. The whole output for the year amounts to about 33,000 square miles (still leaving 1,350,000 to be completed) at an approximate cost of 31.4 rupees per square mile (say 2*l.*). Certain small areas of forest on scales of 3 in. and 4 in. per mile are included, so that this output of the twelve small parties employed must be considered very satisfactory. The geodetic operations include (besides direct triangulation and the magnetic surveys) pendulum, tidal, and levelling observations of great scientific value. More than one million maps have been turned out in the map department, including topographical, geographical, and general maps, amongst which are twelve sheets of the "one millionth" map of the world, which are now reduced to uniform style so as to take their place with similar sheets of the series published by the Royal Geographical Society and elsewhere. The colour system adopted by the Survey of India for defining differential altitudes in planes of different tints is not beyond criticism. The highest altitudes (next the regions of perpetual snow) are coloured a blood-red. The result when applied to Tibet is almost comic in its blazing determination to secure due recognition for the "Roof of the World." T. H. H.

PHYSICS IN RELATION TO NATIONAL LIFE.[1]

ABOUT one hundred years ago—in the year 1808—Dr. Thomas Young, one of the greatest of English physicists, published his "Lectures on Natural Philosophy." They had been delivered a short time

[1] From a lecture delivered on April 27 by Sir Richard Glazebrook, C.B., F.R.S., in a course on "Science and the Nation," arranged for science teachers by the London County Council Education Committee.

previously at the Royal Institution, and are a storehouse of physical science as it was then known. In his introduction he says:—"The dissemination of the knowledge of natural philosophy and chemistry becomes a very essential part of the design of the Royal Institution, and this department must in the natural order and arrangement be anterior to the application of the sciences to practical uses. To exclude all knowledge but that which has already been applied to immediate utility would be to reduce our faculties to a state of servitude and to frustrate the very purposes which we are labouring to accomplish. No discovery, however remote in its nature from the subjects of daily observation, can with reason be declared wholly inapplicable to the benefits of mankind."

The lectures cover the whole range of physics as it was then known, and in the last, the sixtieth, the author concludes:—"When we reflect on the state of the sciences in general at the beginning of the seventeenth century and compare it with the progress which has been made since then in all of them, we shall be convinced that the last two hundred years have done much more for the promotion of knowledge than the two thousand which preceded them, and we shall be still more encouraged by the consideration that perhaps the greater part of these acquisitions have been made within fifty or sixty years only. We have, therefore, the satisfaction of viewing the knowledge of Nature, not only in a state of advancement, but even advancing with increasing rapidity."

Dr. Young lived one hundred years ago, and if then these words were true, how much more true are they to-day! The rate of growth of our knowledge of inanimate Nature in the past twenty years or so has far surpassed anything he ever contemplated, and the benefits that growth has brought mankind far exceed all he ever dreamed of. Not that they are all benefits; the terrors of war, the sufferings of the innocent, the poison-gas shell, the bomb that kills women and children, and the nameless horrors Science has put it into the power of human fiends to deal around forbid that comforting dream.

Still, there is no doubt which way the balance turns. Contemplate modern life without physics—the science of energy; think of it with our knowledge of electricity, what it was even when Young wrote, with the steam-engine almost a toy, with ships dependent still upon the wind and tides, with the engineer compelled to use human labour, assisted only by the simpler mechanical devices, such as the inclined plane or some elementary arrangement of pulleys for his buildings and bridges.

Physics guides us in directing the national stores of energy into channels useful to man; it is to this power that man owes his supremacy over the brute creation, and it is to the discovery of those natural laws which are the subject of study of the physicist that this power is due. This statement of our subject is sufficient to indicate its extent. Clearly, to treat in turn of all its branches and indicate their connection with our national life is a hopeless task for an hour's lecture. There is not time to deal completely even with one, and yet I think some appreciation of what we owe to physical science may be gained if I attempt a very brief review of our knowledge of electricity one hundred years ago and of its progress since that date.

The age was a fertile one. Cavendish was still working, and had discovered many of the laws of statical electricity; he had shown how to combine oxygen and hydrogen to form water, and had used the electric arc to produce nitrogen from the air.

On the Continent Coulomb had verified experimentally the inverse square law for electricity by the use of the torsion balance, and had investigated its distribution on conductors of various forms. Laplace and Poisson were active in applying mathematical calculations to problems in electrostatics, and somewhat later (1828) George Green, the self-taught mathematician—he was a Nottingham shoemaker who, after the publication of the paper referred to, entered at Caius College, Cambridge, became fourth Wrangler in 1837, and died in 1841—made by far the most important advance up to that date in electrical theory. The Leyden jar had long been invented, and some experiments had been made on currents produced by discharging a series of condensers (Leyden jars) through long wires or obtained through statical electrical machines; little was known of the properties of the current, because no means of producing continuous currents existed.

The science of magnetism was in a similar elementary condition. Gilbert, of Colchester, physician to Queen Elizabeth, in his treatise "De Magnete," published in 1600, had described the fundamental facts of the subject, and Coulomb had applied the torsion balance to prove the inverse square law for magnetism; there was a vague idea that there must be some connection between electricity and magnetism, but of electro-magnetism and all the vast possibilities it implied there was no conception. With the new century came a change, though even then progress, which to Young, writing in 1808, seemed rapid, to us seems slow.

In 1800 Volta invented the voltaic pile, a pile of discs of zinc and copper, alternately separated by flannel washers moistened with dilute acid; a considerable e.m.f., depending, of course, on the number of couples, is produced between the extreme discs, and a small current can be drawn from the apparatus. Then came his "crown of cups," the primitive form of battery, a plate of zinc and copper dipping into a vessel (a cup) filled with dilute acid, and connected by a wire outside the vessel; a number of these arranged in series formed the crown.

Twenty years later (in 1820) came Oersted's great discovery, described in his "Experimenta arca effectum conflictus electrici in acum magneticum," in which he described for the first time the action of a current on a magnet; the ordinary method of measuring a current by the deflection of a magnet was a natural result, and Schweigger invented the galvanometer, while Ampère with wonderful rapidity established elementary laws which regulate the action of one current on another, and laid the foundation of electrodynamics. In the same year Arago, followed in 1821 by Sir Humphry Davy, discovered independently the power of a current to magnetise steel. Arago's further discovery in 1824 of the rotation of a magnet when suspended freely over a rotating copper disc led ultimately to results of the very greatest importance, which culminated in 1831 in Faraday's discovery of the induction of electric currents and the elucidation of their laws.

The child was born whose birth was soon to be of such immense consequences to mankind, but probably no one, not even Faraday himself, realised all that was to follow.

In 1827 Ohm stated the law now universally known by his name, and its statement led to much important work with a view to its complete verification. The fundamental laws of electrolysis were enunciated by Faraday in 1833, and for long there was an ardent controversy as to the source of the electromotive force in a galvanic cell.

By the middle of the century the foundations of the science were well and truly laid; its influence on national life had until then been but small, but the ground was secured on which to build safely the structure of the practical applications of electricity. In the last seventy years theory has advanced no less than practice; indeed, as we shall see later, some of the most important recent practical advances are the outcome of very recent theory; but the fact remains that for real progress the practical application of a science must rest upon a secure basis of theory; only then will its progress be rapid and uninterrupted.

Ampère's experiments and Faraday's researches had indicated various methods by which motion could be produced owing to electro-magnetic action, or conversely, by which currents could be generated in conductors moving in magnetic fields, and as a result numerous inventors produced magneto machines. Faraday himself used one made by Pixie. In Saxton's machine, employed frequently towards the middle of last century, two coils wound round a soft iron armature rotate in front of the poles of a strong permanent magnet somewhat as is done in the spark magneto of the present day.

Werner Siemens in 1857 invented the Siemens armature; the next step was to replace the permanent magnets by electromagnets excited by a separate small machine. Wilde's machine (1867) was of this class, and in the same year Wheatstone and Werner Siemens enunciated the principle of the modern self-exciting dynamo, in which the remanent magnetism of the field coils is utilised to start a feeble current in the rotating armature; this current is led round the field coils, thus reinforcing their magnetism, and in this manner the powerful currents generated by modern machines are built up.

So far, the fundamental principles established by Faraday had been the basis of the work done. Various distinguished men contributed to advance the theory and to improve practice. About this time the Electrical Standards Committee of the British Association began its labours. Appointed at the instance of Lord Kelvin (Sir William Thomson) in 1861, during the period 1862–70 it made a series of reports which have been of fundamental importance in the theory and practice of electricity. It was re-appointed in 1881 at the suggestion of Prof. Ayrton, and continued to do useful work until 1913, when it was felt that the National Physical Laboratory was carrying out the duties for which it had been organised.

Lord Kelvin, in his work connected with the Atlantic telegraph, had realised very fully the need for a consistent system of units of measurement. Such a system had been proposed by Weber, and the committee in the end was led to adopt as fundamental the C.G.S. (centimetre-gram-second) system of units, and base on it the practical system of electric units—the ohm, the ampere, and the volt—now in use everywhere. It is impossible to overestimate the practical effects of this action. In the first place, electricians throughout the world speak a common language, and the results of researches are intelligible to all alike; in the second, that language is a consistent and logical one, electrical quantities are connected together and linked with the fundamental conception of energy in the simplest manner possible, and in a way which permits of accurate numerical calculation.

As a result of the labours of the distinguished men who formed the committee and their colleagues at home and abroad, we had the means of measuring with high accuracy current, electromotive force, and resistance, together with a number of other dependent electrical quantities.

Another step was needed to complete the theory of the dynamo: to permit the manufacturer to design on scientific principles a machine which for a given speed of rotation would transform mechanical into electrical energy at any required rate in the form of a given current at a known voltage.

The laws of magnetic induction in iron and steel were known but very imperfectly. As has already been stated, Arago and Davy had discovered in 1820 that iron was magnetised by a current; Poisson and others had given theories of this induced magnetism; Kelvin in his earlier papers had done much to clear up ambiguities and to give definiteness to the terms used. Rowland, in America, carried out numerous experiments of great value, but it is to Ewing and Hopkinson that we owe our first real knowledge of the importance of the magnetisation curve, the meaning of the property known as hysteresis, which had a short time previously been investigated by Warbury, and the part this plays in the action of electrical machinery.

The experiments of Oersted and Ampère had taught us that an electric current circulating in a coil of wire produces a field of magnetic force linked with that coil, and, as Faraday proved, the inductive effects produced in any neighbouring circuit depend on the manner in which that circuit is also linked with the magnetic lines.

John Hopkinson in 1879 had shown how the properties of a dynamo could be deduced from its characteristic curve, the curve connecting the e.m.f. in the armature with the exciting current in the field coils; and in a joint paper with his brother Edward, read before the Royal Society in 1886, he described how the form of this curve could be obtained graphically for a dynamo of known design and dimensions from the ordinary laws of electro-magnetism and the known properties of iron which Ewing had shown how to determine. The theory of the dynamo was complete in its main outlines. Since then progress has been rapid. Theory has indicated the direction in which improvements were to be sought; the skill of the metallurgist, the engineer, and the designer has been called in to put those improvements into practice.

The result you know. Conceive the world without electric power—London without its tubes and railways, its electric light, telephones, telegraphs, and wireless services—and you will realise to some degree what is due to the labours of the physicists under whose skilled guidance all this system has grown up in the last twenty-five or thirty years out of the small seed sown by Faraday and his contemporaries.

It is not easy to obtain figures which give with accuracy the extent to which electrical power is used at present. In the Electrical Trades Directory for 1917 it is stated that more than 500,000,000*l.* has already been sunk in the industry, and there is every prospect of that sum being largely increased.

I have endeavoured to indicate in brief outline the process by which this stupendous result has been achieved. In the first place, we have the disinterested labours of the man of science impelled by the desire to know; then have followed the mathematician and the physicist, whose work has reduced the early observations of the experimenter to the rule of law, and when that law has been established it has become possible for the electrical engineer to grasp the problem and apply the teaching of the physicist to the needs of national life.

Illustrations of the process, proofs of the debt due to physics, could be taken from many other branches of science did time permit. The development of the steam-engine did not at first depend to any large extent on exact measurement and physical research. Progress was comparatively slow until Rankin and Kelvin developed the thermodynamics of steam—work continued in our own time by many well-known names, and turned to practical use of the highest importance by Parsons in the development of the turbine.

When the story of the past four eventful years can be fully written, the nation will realise to an extent it has never done before the importance of physics to our national life. What conclusions can we who do realise this draw from the facts I have imperfectly put forward? What lessons are there for the time that is to come, that reconstruction period, which, if rightly used, will mean so much to England? We must, to begin with, give the man of science a freer hand, a better chance to develop his discoveries; and, in the second, with this object we must educate the people to appreciate more fully the importance of science.

Men who can make great discoveries are few in number; increase the opportunities for their work when found, and encourage all that may help to develop them. Such a man may come from any rank of life. Mr. Seaton, in an interesting paper on the importance of research in marine engineering read recently before the Institution of Naval Architects, in directing attention to the fact that many inventions of importance to engineers have been made by men who were not engineers, writes thus:—"Bramah, one of the first to suggest the screw-propeller, was a blacksmith and locksmith; George Stephenson a fireman; "Screw-propeller" Smith, who patented a good workable propeller, was a farmer. . . . The inventor who exhibited an internal-combustion engine at Cambridge a hundred years ago was a parson; so also was Ramus, the inventor of the hydroplane ship. James Watt was an optical-instrument maker; the inventor of the chronometer was a gardener. "Increasing-pitch" Woodcroft was a librarian, Bessemer an artist, Armstrong a lawyer."

Though in these days of increasing specialisation the task of the amateur discoverer grows daily more severe, the importance, in the first place, of the educational ladder to give any boy of real talents his chance, and, in the second, of providing for the man who has proved he can advance knowledge and may make a real discovery, is paramount. No doubt the chances of success are small. Many will set foot on the ladder and climb to a greater or less height, but few will reach the top. No doubt also the selection of those who should be encouraged is difficult; examination success is by no means always the surest test, yet it is not easy to frame another. But then the discoveries of the men of science are rarely in a form to be assimilated directly by industry and to become available for the national advantage. It was a long step from Faraday's researches to the dynamo and motor of to-day; or from the Faraday dark space and Hittorf's experiments with cathode rays, and Röntgen's discovery of the X-rays, to the Coolidge tube and the X-ray outfit of the modern Army hospital; or, again, from Kelvin's paper on electrical oscillations in 1855, or Helmholtz's first suggestion of the same in 1847, to the modern developments of wireless telegraphy.

What action can we take to bridge the gulf, to render scientific discovery more readily available and to spread more widely knowledge which may be of the utmost service to the manufacturer? This I take to be the work of laboratories of industrial research, which I hope to see grow up in the various great centres of industry. In such a laboratory the staff are studying continuously to bring scientific knowledge as it advances to bear on industrial problems. They must be skilled experimenters with a sound knowledge of recent discoveries, a real zeal for the work they have undertaken, and a deep-seated belief in its importance to the nation. The laboratory must be equipped in a complete manner with plant and apparatus such as would be found in works, prepared to carry out the investigations necessary before a new process or idea, the outcome of some laboratory investigation, can be applied on a works scale.

For such work special laboratories and conditions are essential. The National Physical Laboratory should be one such; in time, a central institution for this task, correlating the work of the various local institutions, carrying out work which might be common to a number, and serving as a centre from which information is disseminated, and to which manufacturers will come for suggestions and guidance.

All this, however, will be of little avail unless the nation as a whole learns to appreciate its importance. What is to be done to evoke a more intelligent interest in physics among men at large; to induce our legislators to realise the necessity for large expenditure and generous support; to evoke a general faith in the efficacy of scientific method which would go so far to hearten and encourage the patient worker?

I am speaking mainly to teachers; let me, in conclusion, address a few words to you specially as such. If I have convinced you of the importance of my subject—many needed no convincing, I am sure—may I remind you that it is your great task to arouse this faith; to lead the rising generation to look on physical science, not as something outside and apart from their daily life, but as a source of strength and progress; to educate them so that they may realise more fully what they owe to the great men of the past who have sowed the seeds of England's power, and what they must do to preserve the heritage these men have handed down to them?

But how? The question is a difficult one to answer. There is a loud call for a more generous recognition of science in our schools, for curricula in which it has a larger share in the time-table, for more recognition for its teachers and more prizes and scholarships for its students. While this is most desirable, it is not enough; alone it will do little. Lord Bryce in a recent article writes:—"No man can be deemed educated who has not some knowledge of the relation of the sciences to one another and a just conception of the methods by which they respectively advance." Will the student gain this education merely by transferring him for so many hours a week from the literary side to the scientific side of the school? I fear not. Reform is needed in our methods of science teaching. I speak as one responsible in part for those methods with a consciousness of some fault. Forty years ago it was my privilege to organise, along with my colleague, Sir Napier Shaw, the teaching of practical physics at the Cavendish Laboratory. We were dealing, under difficulties, with young university students preparing to take a degree in science or medicine, men proposing to specialise. We had learnt the necessity for exact measurement in all research, the importance of a personal acquaintance with the methods by which our knowledge had been advanced; we were not then concerned with the general education of the vast mass of boys and girls throughout the country, and so we devised and extended the methods of practical physics. We made each student verify Ohm's law, measure the specific capacity for heat of copper, or the wave-length of sodium light; and that method, devised for a special purpose for which I still think it the most useful, lent itself to the examiner and the teacher as a method by which the mass of pupils could be instructed and examined. It has been extended and developed by many able and enthusiastic men; too often it is elaborated so far as to be little more than press the button and note what happens. You have then proved that the pressure of a gas at constant volume is proportional to its temperature.

In the case of the ordinary boy and girl the results have little more influence on their lives than the lists of the kings of Israel or the emperors of Rome, or the exceptions to some abstruse rule of grammar. They have been forced to learn by heart in order to train their memory. Sir Napier Shaw has recently written thus:—"When we come to consider such provision as there is for science in general education as represented by the opportunities actually offered to boys and girls at school, it is for me impossible to avoid the conclusion that what the exponents of physical science have evolved as the elements of scientific education is quite unworthy of the subjects we wish to expound."

If this be so, how then are we to remedy it? The question is one too difficult to answer at the end of a long lecture. I think a remedy is possible. The teacher ought, I feel sure, to be able to arouse an interest in the principles of his subject without a wearisome attention to details; to give to a class the general idea of what is involved in the ordinary laws of Nature; of what we mean by energy or momentum, the conservation of energy or the mechanical equivalent of heat; of the connection between electricity and magnetism and the historical development of the various laws about which he has been speaking—in fine, to give the pupil some knowledge of the relation of the sciences to one another and a just conception of the means by which they advance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A CONFERENCE on women in industry will be held under the auspices of the Industrial Reconstruction Council on Tuesday, October 22, at 6 p.m., in the hall of the Institute of Journalists, 2 and 4 Tudor Street, E.C.4. The subject will be introduced by Miss Lilian Dawson, after which the discussion will be open. No tickets are necessary.

A COURSE of three public lectures on "France's Share in the Progress of Science" will be delivered at University College on Tuesdays, October 22 and 29 and November 5, at 5 p.m., by M. Henri L. Joly, professeur de sciences physiques et naturelles au Lycée Français (Institut Français du Royaume Uni). The chair will be taken at the first lecture by Prof. J. Norman Collie. A leaflet containing a full syllabus of the lectures may be obtained by sending a stamped addressed envelope to the Publications Secretary, University College, London (Gower Street, W.C.1).

THE Armstrong College (Newcastle-upon-Tyne) calendar will not be published for the current session, but the prospectus of day classes, a copy of which has reached us, contains the essential particulars respecting the courses of work in pure and applied science which have been arranged for the academic year 1918–19. Students of pure or technical science in the college may proceed to the degrees in science of the University of Durham, of which the college is a part, and, according to the number of years of study, may present themselves for graduation as bachelor, master, or doctor of science, or as doctor of philosophy. For the degrees of master and doctor great importance is attached to success in research. We have received also the current calendar of the Royal (Dick) Veterinary College, Edinburgh, which was founded in 1823 by the late Prof. Dick, and endowed by him, his sister, and Mr. A. I. MacCullum. The college prepares its students for the diploma of membership of the Royal College of Veterinary Surgeons and degrees in veterinary science in the University of Edinburgh, and also offers facilities for post-graduate work.

SOCIETIES AND ACADEMIES.

MELBOURNE.

Royal Society of Victoria, July 11.—Mr. J. A. Kershaw, president, in the chair.—C. **Fenner**: The physiography of the Werribee River.—Prof. T. H. **Laby** and E. O. **Hercus**: The thermo-conductivity of air.

SYDNEY.

Linnean Society of New South Wales, March 27.—Prof. H. G. Chapman, president, in the chair.—Dr. A. B. **Walkom**: The geology of the Lower Mesozoic rocks of Queensland, with special reference to their distribution and fossil flora, and their correlation with the Lower Mesozoic rocks of other parts of Australia. The Lower Mesozoic rocks of Queensland comprise three divisions—the Ipswich, Bundamba, and Walloon series. The Ipswich and Bundamba series are of comparatively limited distribution, and are confined to the south-eastern portion of the State. The Walloon series has a much greater extent; in addition to occurring in south-eastern Queensland, in association with the Ipswich and Bundamba series, it outcrops in a belt along the western slope of the Main Divide from the New South Wales border to Cape York, dipping westerly beneath the marine Cretaceous. It probably underlies the Cretaceous strata over the greater part of western Queensland. In eastern Queensland there are a number of small isolated occurrences of the Walloon series. The thicknesses of the three series are, approximately: Ipswich series, 2000–2500 ft.; Bundamba series, 3000–5000 ft.; and Walloon series, up to 10,000 ft. A comparison of the Queensland Lower Mesozoic strata with other occurrences in Australia of similar age seems to show (1) that the Narrabeen and Hawkesbury Sandstone stages in New South Wales are older than the Ipswich series; (2) that the Wianamatta stage of the Hawkesbury series in New South Wales, and also possibly part of the Lower Mesozoic strata of Tasmania, are of the same age as the Ipswich series; and (3) that the following series in the other States are of the same age as the Walloon series: The Artesian series, Clarence series, and Talbragar beds in New South Wales; the Jurassic strata of the South Gippsland, Cape Otway, and Wannon areas of Victoria; the Leigh's Creek beds in South Australia; part of the Lower Mesozoic strata of Tasmania, and the marine Jurassic series in Western Australia.—Dr. R. J. **Tillyard**: (1) Studies in Australian Neuroptera. No. 5: The structure of the cubitus in the wings of Myrmeleontidæ. An examination of the pupal tracheation of the fore-wing of *Xantholeon helmsi*, Tillyard, reveals the presence of the original archaic Cu_2 close to the base of the wing, where it fuses with 1A. The veins hitherto called Cu_1 and Cu_2 respectively are shown to be, in reality, Cu_{1a} and Cu_{1b}. As a result, the position of the tribe Creagrini within the subfamily Dendroleontinæ has to be revised, the genera included in it being shown to be much more highly specialised than has hitherto been thought possible. The phylogenetic stages by which the condition of Cu in the fore-wing of Myrmeleontidæ has been reached are shown to be still existent in some ancient types of Hemerobiidæ. (2) The affinities of two interesting fossil insects from the Upper Carboniferous of Commentry, France. The paper discusses the affinities of *Megagnatha odonatiformis*, Bolton, and *Sycopteron symmetrica*, Bolton, described from the types in the "Mark Stirrup" collection, Manchester Museum. The former is assigned by Bolton to the Perlaria, with possible relationship to the Sialidæ. These affinities are disproved, and the suggestion is made that the insect is, in reality, an ancient representative of the Embioptera. A detailed comparison is made with the recent genus Oligotoma. The Sycopteron is assigned by Bolton to the Mecoptera. This is shown to be extremely doubtful, and a much closer resemblance is proved between the fossil and the Psocopterous genus Amphientomum (Oligocene and recent).

April 24.—Prof. H. G. Chapman, president, in the chair.—Dr. H. L. **Kesteven**: The origin of yolk in the ova of an endoparasitic Copepod.—Dr. R. Greig **Smith**: Contributions to a knowledge of soil fertility. No. 16: The search for toxin producers. It has been shown that certain soil bacteria, moulds, and amœbæ, all reasonably supposed to be capable of furnishing substances of a toxic nature, were grown in various media and under varying conditions, and in all cases the signs of toxicity which became manifest could be attributed to an alteration in the reaction of the media. The test organism, *Bacterium prodigiosus*, grows best in a neutral medium, and an indicator is required which will indicate strict neutrality. The methyl-orange numbers are too high, and the phenolphthalein too low. Small divergences from the neutral point strongly affect the growth. The humus of leaf-mould contains two types of humic acid; one absorbs alkali from alkaline carbonates, and the other from alkaline carbonates and hydrates. These were present to the extent of one part of the former to three of the latter. Heating the humus increases the amount of acid, and the increase is largely soluble in water. The effect of reaction is quite of a different order from the evidence of toxic action obtained in former researches.—J. J. **Fletcher** and C. T. **Musson**: Certain shoot-bearing tumours of Eucalypts and Angophoras, and their modifying influence on the growth-habit of the plants.

BOOKS RECEIVED.

A Memoir on British Resources of Refractory Sands for Furnace and Foundry Purposes. Part i. By Prof. P. G. H. Boswell, with Chemical Analyses by Dr. H. F. Harwood and A. A. Eldridge. Pp. xii+246+plates xi. (London: Taylor and Francis.) 8*s*. 6*d*. net.

The Modern Geometry of the Triangle. By W. Gallatly. Second edition. Pp. vii+126. (London: F. Hodgson.) 2*s*. 6*d*. net.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. iv., part 5. (Sydney: The Government of the State of New South Wales.) 2*s*. 6*d*.

Studies in Clocks and Time-keeping No. 2. Tables of the Circular Equation. By Prof. R. A. Sampson. (Edinburgh: R. Grant and Son.) 2*s*. 10*d*.

A Monograph of the British Lichens: A Descriptive Catalogue of the Species in the Department of Botany, British Museum. By A. Lorrain Smith. Second edition. Pp. xxiv+520+71 plates. (London: British Museum (Natural History).) 30*s*.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 17.

INSTITUTION OF GAS ENGINEERS, at 10.—Lt.-Col. Arthur Smithells and Prof. John W. Cobb: Preliminary Report of the Gas Investigation Committee.—B. R. Parkinson: Life of Gas Meters Research Committee Communications on "Unaccounted-for Gas."—J. G. Taplay: Corrosion of Dry Gas Meters.—Dr. J. W. Mellor: Report of Refractory Materials Committee.—Walter Emery and Dr. A. Scott: The Corrosive Action of Flue-dust on Fire Bricks.

FRIDAY, OCTOBER 18.

INSTITUTION OF GAS ENGINEERS, at 10.—Papers from list given above.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.

TUESDAY, OCTOBER 22.

ZOOLOGICAL SOCIETY, at 5.30.—Prof. H. M. Lefroy: Wheat Weevil in Australia.—Sir E. G. Loder, Bart.: Notes on the Beavers at Leonardslee, 1916-18.—G. A. Boulenger: The Madagascar Frogs of the Genus Mantidactylus, Blgr.

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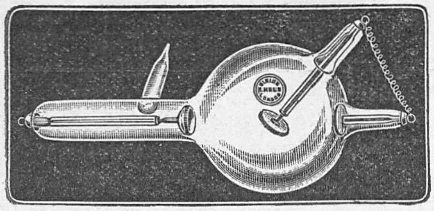

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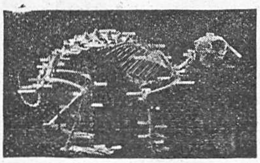

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